DIFFERENTIAL REINFORCEMENT OF EXERCISE BY INDIVIDUALS WITH PRADER-WILLI SYNDROME USING CALORIES AS REINFORCERS

By

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Untreated, individuals with Prader-Willi Syndrome (PWS) suffer from an excessive food appetite, progressive life-threatening obesity, and a wide range of associated health risks. However, with proper treatment, including dietary controls and fitness training, the morbidity of this syndrome can be reduced. Despite the existence of numerous studies that focus on stringent dietary manipulations in the treatment of PWS, a feasible method of establishing and maintaining compliance with exercise programs remains lacking. Furthermore, individuals with PWS are often characterized as resistive, argumentative, and emotional. These features may hamper conventional methods for establishing exercise behavior. Given the apparent heightened susceptibility to food as a reinforcer in PWS, it may be worthwhile to investigate whether food items with particular caloric content or the addition of calories to daily caloric allotment can be successfully used as reinforcers of exercise. In addition, no studies currently exist in which exercise topography, rate and duration are operationally defined and systematically measured with this population.

To this end, the effectiveness of differential reinforcement of exercise with calories was investigated. Seven individuals diagnosed with PWS served as participants. After baseline data were collected, the differential reinforcement of duration and intensity of exercise phases began. Verbal prompts, number of kilocaries provided contingent upon exercise, coupons, and in some instances preferred food items were manipulated. The end result was all participants regularly exercised continuously for 45 minutes at an intensity level sufficient to maintain heart rate in their aerobically beneficial target heart rate zone. Results from this investigation are consistent with the hypothesis that a positive reinforcement program using calories as reinforcers will establish and maintain chronic exercise in persons with PWS. The finding that some participants will choose a delayed reinforcer worth more calories rather than an immediate reinforcer with less caloric value contradicts conventional PWS wisdom as it relates to self-control.

CHAPTER 1
PRADER-WILLI SYNDROME

History and Clinical Phenotype

In 1956, three physicians at the University of Zurich, A. Prader, A. Labhart, and H. Willi, identified a multi-system developmental syndrome. It would eventually be called Prader-Willi syndrome (Butler, 1990; Dykens & Cassidy, 1995, 1996; Thompson, Butler, MacLean, & Joseph, 1996). Articles on Prader-Willi syndrome (PWS) would not emerge until 1968 with diagnostic criteria not identified until much later (Holm et al., 1993). Certainly, PWS was evident before the Swiss doctors cataloged the syndrome. It is possible that artistic representations of the royal family of Spain in the 17th century provide pictorial evidence of PWS (Carpenter, 1989).

The syndrome is discernible across two distinct stages. The first stage encompasses the prenatal period and infancy. It is characterized by reduced fetal activity and abnormal delivery position (Rankin & Mattes, 1996). Infants with PWS generally fail to thrive. This is precipitated by hypotonia, poor sucking reflex, and feeding difficulties, which can necessitate gavage feeding (Butler, 1990; Dykens & Cassidy, 1995, 1996). Frequently infants are described as listless with their cry as "squeaky, kitten-like, or absent" (Holm et al., 1993, p. 400). A weak cry as well as hypothermia, hypogenitalism, and excessive inactivity are among the many characteristics that describe the first stage of development (Butler, 1990; Dykens & Cassidy, 1995, 1996; Dykens, Leckman, & Cassidy, 1996; Thompson et al., 1996; Zellweger & Schneider, 1968).

The second developmental stage occurs around the first or second year of life. This stage is marked by the retardation of psychomotor skills such as crawling or walking (Butler, 1990), decreased pain and vomit threshold, sleep disorders, small feet and hands, short stature (Holm et al., 1993), hypopigmentation and osteoporosis (Butler, 1990). These are but a few of the myriad clinical manifestations evident in stage two (Butler, 1990; Holm et al., 1993; Thompson et al., 1996). It is at this stage hyperphagia develops and childhood obesity occurs (Butler, 1990; Dykens & Cassidy, 1995, 1996).

Hyperphagia is discussed by Dimitropoulos, Feurer, Butler, and Thompson (2001) as "a severe eating disorder" (p. 39). This "insatiable appetite" (Dimitropoulos et al., 2001, p. 39) is believed to be due to hypothalamic abnormality (Dykens et al., 1997). Zellweger and Schneider (1968) initially described hyperphagia as torment "by a persistent hunger during waking hours" (p. 592). This voracious, nagging appetite is not limited to foodstuffs typically ingested by the average free-ranging human. Indeed, cases have been reported in which individuals with PWS have consumed cattle feed, garbage (Altman, Bondy, & Hirsch, 1978; Holm et al., 1993; Pipes & Holm, 1973), pet food (Altman et al., 1978), frozen bread loaves (Caldwell & Taylor, 1983), several entire cases of Ensure and condiments, hamster pellets, and even the family parakeet. According to Thompson et al. (1996), "Though a cluster of commonly covarying clinical features are exhibited by people with this syndrome, only the eating disorder is common to all affected individuals" (p. 188). Additionally, hyperpahgia is polyphagic in nearly 100% of all cases reported (Thompson, Kodluboy, & Heston, 1980).

Hyperphagia is the major cause of PWS obesity according to Fieldstone, Zipf, Schartz, and Bernston (1997), and obesity is the "cardinal feature in PWS individuals" (Butler, 1990, p. 322). Approximately one third of all individuals diagnosed with PWS weigh in excess of 200% of their ideal body weight (Butler, 1990). Weight gain is explosive between ages 1 and 4. It leads to obesity of "Pickwickian dimensions in later years" (Pipes & Holm, 1973, p. 520). This distribution of body fat has been described elsewhere in terms of Pickwickian proportions (Altman, Bondy, & Hirsch, 1978; Carpenter, 1989) with fat disproportionately deposited "on the trunk, buttocks, and proximal part of the limb" (Pipes & Holm, 1973, p. 520). By the time PWS children become teenagers, they can weigh anywhere between 250 to 300 pounds if food consumption remains unchecked (Butler, 1990). This morbid obesity is the main health consideration in PWS and is considered to be very change resistant (Butler, 1990).

Morbid obesity in PWS is indeed life threatening (Fieldstone et al., 1997). It is associated with a plethora of related health risks evident to one degree or another in the PWS population. Among those risks are diabetes mellitus (Clarke, Waters, & Corbett, 1989; Fieldstone et al., 1997; Greenswag, 1987), high blood-pressure, stroke, infection and cellulitus (Greenswag, 1987), respiratory difficulties (Greenswag, 1987; Hoffman, Aultman, & Pipes, 1992), scoliosis, ophthalmologic complications (Greenswag, 1987; Thompson et al., 1996), the reduced caloric requirements for weight loss and maintenance compared to leaner counterparts (Thompson et al., 1996), somnolence, cardiopulmonary compromise, and subsequent death (Fieldstone et al., 1997).

Originally, impaired intellectual functioning was one of the four criteria defining features of PWS (Thompson et al., 1996). Individuals with PWS are typically developmentally delayed to some extent with "mild to moderate mental retardation" (Dykens, 2002, p. 343). Generally, IQ falls within the 55 to 70 range, which is considered indicative of mental retardation (Thompson et al., 1996); however, the range of intelligence representative of PWS is generally higher than that of "other genetic mental retardation syndromes" (Dykens & Cassidy, 1996, p. 917) such as Down or fragile X syndromes. "Adaptively, however, even high-functioning individuals rarely function at a level commensurate with their IQs, because of interference from food-related and other behavioral issues" (Dykens & Cassidy, 1996, p. 917).

Etiology and Prevalence of Prader-Willi Syndrome

Prader-Willi syndrome is a genetic disorder (Dimitropoulos et al., 2001). It is the result of a paternal deletion of part of "the proximal long arm of chromosome 15" (Dimitropoulos et al., 2001, p. 39). In fact, this deletion accounts for 70% of PWS cases (Clarke, Boer, Chung, Sturmey, & Webb, 1996; Dimitropoulos et al., 2001; Fieldstone et al., 1997; Holm et al., 1993; Ledbetter et al., 1980; Thompson et al., 1996). Twenty-five percent of PWS patients have "both members of the chromosome 15 pair from their mother and no chromosome 15 from their father. This phenomenon is called *maternal uniparental disomy* of chromosome 15" (Thompson et al., 1996, p.192). The residual 5% of PWS cases are due to other chromosomal anomalies or "genetic imprinting errors" (Thompson et al., 1996, p.195).

If a *maternal* deletion occurs at approximately the same site, or if paternal uniparental disomy happens the result is Angelman syndrome (Thompson et al., 1996). Genetic imprinting in humans was identified for the first time in these two related syndromes. Genetic imprinting is "the differential expression of genetic information whether inherited from the mother or from the father" (Thompson et al., 1996, p. 193). The cause of DNA abnormalities in PWS is largely unknown (Butler, 1990); however, paternal exposure to hydrocarbon has been implicated (Butler, 1990; Thompson et al., 1996). The prevalence of PWS is 1 in 12,000 live births. Reportedly, more males than females are diagnosed with PWS. This is perhaps due in part to the relative ease with which the diagnosis is made in males compared to females. Approximately 1 out of every 10,000 to 20,000 people are affected by PWS. Prader-Willi syndrome is reported among all ethnicities but to a greater extent for Caucasians; however, the extent to which such disproportionate reports are indicative of differences in true base rates remains unknown (Thompson et al., 1996).

Given that this syndrome is not very prevalent comparatively, Thompson et al. (1996) proposed several reasons why resources should be directed toward the study of PWS. Among those reasons is the reduction of suffering and concomitant costs associated with treatment. Thompson et al. also stipulate that the possibility exists for discovering a link between various eating disorders such as bulimia and PWS. Thompson et al. (1996) also mention that the development and subsequent evaluation of a method for studying PWS can be used in research efforts designed to examine other "genetically based behavior disorders associated with developmental disabilities (e.g., autism, de Lange syndrome)" (p. 207).

Behavioral Phenotype

At present, syndrome research (Prader-Willi, Angelman, Fragile X, Smith-Magenis, and Rett syndromes) is burgeoning with the contributions of behavior analysts clearly recognized (Dykens, 2001). Dykens (2001) describes their role as pivotal. She insists, "behavioral experts are needed to solve the behavioral half of these gene-behavior puzzles" (p. 1). Information on behavioral phenotypes is very useful for treatment guidelines. Prader-Willi syndrome is one syndrome for which phenotypic data are at last emerging. The examination of "genotype-phenotype correlations" (Dykens, 2001, p. 1) is one area of inquiry in need of exploration.

A significant number of PWS patients share a common set of behavior problems that emerge during childhood. Dimitropoulos et al. (2001) systematically studied a sample of 105 children with PWS in an effort to determine the prevalence of specific behavior problems and age of onset. Their results supported the reports of other investigators (Clarke et al., 1996; Dykens, 2002; Thompson et al., 1996). Behavior considered to be compulsive (e.g., hoarding, ritualistic removal then subsequent replacement of items, insistence upon completing chores while resisting help from others) emerges around ages 1 to 2 with the intensity of the behavior increasing with age (Dimitropoulos et al., 2001).

Skin picking, also considered to be compulsive, is a common self-injurious behavior. Skin picking is a serious problem with the PWS population and, if untreated, death may result. Forty percent of PWS children and 70% to 80% of adults engage in this particular type of self-injurious behavior (Dimitropoulos et al., 2001).

Explosive temper tantrums are also among the subset of behavior problems exhibited by individuals with PWS. Dimitropoulos et al. (2001) considers the onset of tantrums to be “rapid” (p. 48) and correlate highly with the onset of significant increases in appetite; however, “the causal link between the eating disorder and the behavior problem is not entirely clear” (p. 46). Another related behavior that is problematic and considered by Dykens et al. (1997) to be the “hallmark” (p. 995) of this syndrome is incessant food-seeking behavior, although problem behaviors unrelated to food are very common (Joseph, Egli, Koppekin, & Thompson, 2002). Devious measures are often employed to seek out food. Caregiver attempts to impede food-seeking behavior and limit access to food are often met with behavior that may be characterized as aggressive or violent (Dimitropoulos et al., 2001; Thompson et al., 1980).

Prader-Willi preschoolers are distinguishable from other children affected by genetic disorders (e.g., Down syndrome) and typically developing children by their compulsive and tantrum behaviors as well as related behaviors. Additionally, children and adolescents with PWS are less active than their normally developing peers (van Mil et al., 2000). According to Dimitropoulos et al. (2001), "Recent findings point to possible combined peptidergic, neurochemical, and environmental factors as contributors to the Prader-Willi syndrome behavioral phenotype" (p. 46). Individuals with PWS are also described as very stubborn (Dimitropoulos et al., 2001; Thompson et al., 1996) even oppositional defiant (Clarke et al., 1996), argumentative, manipulative, highly emotional and as having trouble discriminating social cues and impoverished social relationships (Dimitropoulos et al., 2001; Thompson et al., 1996).

The development of language is reported to be impaired in PWS patients. Akefeldt, Akefeldt, & Gillberg (1997) compared 11 individuals with PWS (ages ranging from 4 to 25) to normally developing individuals matched for age, IQ, sex and body mass. They found that the speech and some language skills of the PWS group were generally impaired as measured by commonly used Swiss standardized tests. For example, the resonance of their voices was characterized as hypernasal with pitch levels "abnormally high" (p. 305). Deficiencies were also identified in oral motor ability and spontaneous articulation. These speech alterations are reportedly specific to PWS. Differences in comprehension, grammar, and phonology were however negligible between the two groups. For those individuals for whom impairments in these areas were observed, the deficits appeared to be a function of "mental retardation rather than with PWS per se" (Akefeldt et al., 1997, p. 309).

In comparison with what investigators know about the maladaptive behavior emitted by individuals with PWS, far less is known about their behavior strengths. Tasks designed to assess "attention to visual detail, visual-motor coordination, perceptual planning, and spatial organizations" (Dykens, 2002, p. 343) have revealed these areas to be strong points for this population. Anecdotal evidence holds that the word search ability and jigsaw puzzle skills of persons with PWS are uncanny. According to Dykens (2002), "Puzzle skills may take advantage of the visual-motor strengths shown by many with the syndrome, as well as their obsessive-compulsive tendencies, and needs for order, exactness, and for things to be 'just right'"(p. 343).

Elizabeth Dykens (2002) published the very first study designed to examine word search and jigsaw puzzle skills using materials that were specially constructed for that purpose (e.g., number of stimuli held constant). She also studied the performance of PWS patients on a variety of standardized tasks designed to assess visual-spatial ability (e.g., Developmental Test of Visual-Motor Integration, Object Assembly portion WISC-III, the K-ABC triangles), vocabulary, composite IQ, and ability to solve matrices (e.g., Kaufman Brief Intelligence Test). The PWS participants' performances on these measures were compared to that of peers matched for age and IQ, as well as normally developing counterparts with IQs in the normal range that were also age matched.

The scores of the PWS participants were higher than those of the age and IQ matched sample but lower than those of the normal comparisons. In spite of developmental delay and reduced IQ, they "*outperformed* them on the jigsaw puzzles, placing more than twice as many pieces as the typically developing group" (Dykens, 2002, p.343). Dykens (2002) discussed these skills in terms of "splinterskills" (p. 349) seen with autism. Splinter skills are those typically not considered to be noteworthy or astonishing unless demonstrated by a developmentally delayed individual. They are, however, considered to be above the intellectual level of the individual. Dykens (2002) concludes, "Such observations are particularly intriguing in light of recent connections between autism and chromosome 15 anomalies, especially in the region of 15q11, which encompasses the Prader-Willi/Angelman syndrome region" (p. 350).

Individuals with PWS also reportedly excel in the domain of daily living skills (e.g., domestic abilities). Dykens, Hodapp, Walsh, and Nash (1992) measured the daily living, communication, and socialization skills of PWS children using the Vineland Adaptive Behavior Scales and Achenbach's Child Behavior Checklist. The results of this study indicated that the daily living skills of individuals with PWS were indeed strengths, whereas weakness were identified in the domains of socialization—especially coping skills and communication (e.g., lying, arguing, swearing). Significant correlations between IQ and level of impairment were also found. The authors stated that, "It may be that the developmental course of adaptive behavior in Prader-Willi syndrome is best predicted by the trajectory of their intelligence" (Dykens et al., 1992, p. 1131). Other researchers have reported weakness in arithmetic ability and visual and motor short-term memory. Alternatively, strengths were reported in reading decoding and comprehension, expressive vocabulary, and perceptual organization (Dykens & Cassidy, 1996).

Medical Treatment of Prader-Willi Syndrome

Pharmacological interventions aimed at reducing hyperphagia and life-threatening obesity have met with little success (Dykens et al., 1997). Pharmacological agents have been administered to PWS patients in an effort to reduce behavior problems such as compulsions, aggressive behavior, and SIB; facilitate weight loss and reduce hyperphagia; and enhance bodily growth and speed up the metabolism (Liquori, 1998).

Outcome studies in these areas are primarily case studies and more controlled research is decidedly needed.

Prior to 1990, controlled trials using anorexic drugs with the PWS population did not exist (Selikowitz, Sunman, Pendergast, & Wright, 1990). Selikowitz et al. (1997) were the first to study the effects of fenfluramine (Ponderax) with a double blind placebo control on short-term weight loss in children and adults with PWS. They reported that the administration of fenfluramine resulted in significant percent change in weight. Aggressive behavior also reportedly decreased but SIB remained unchanged.

According to Tu, Hartridge, and Izawa (1992), the administration of diuretics, thyroid medication and other appetite suppressants (e.g., dextroamphetamine) are not generally successful in the reduction or control of weight or hyperphagia. Tu et al. (1992) summarized the results of several studies and reported the following: (a) no reduction of caloric intake when tryptophan was administered; (b) only slight aggression and weight reduction when fluoxetine (Prozac) was administered; (c) reduced temper tantrum in association with carbamazepine administration; (d) variable outcomes in conjunction with fenfluramine; (e) food intake unaffected when naloxone was given; and (f) the same negligible effects on appetite as a result of naltrexone administration.

Tu et al. (1990) advised against the administration of neuroleptic drugs (e.g., chlorpromazine, haloperidol) in the treatment of PSW symptomology. However, Tu et al. (1990) did report success with one patient for whom carbamazepine was given. Although carbamazepine administration resulted in "remarkable control of violent outbursts" (Tu et al., 1990, p. 1137), the researchers cautioned that more research is indeed needed.

Gastroplasty and other types of surgical procedures (e.g., intestinal bypass and vagotomy) have been conducted to prevent or correct morbid obesity in people with

PWS. These procedures have been largely unsuccessful (Butler, 1990; Carpenter, 1989; Liquori, 1998). Liquori discusses a report (Fonkalsrud & Bray, 1981 as cited in Liquori) in which a PWS patient altered his eating habits by consuming smaller meals more frequently in attempts to overcome the capacity restrictions imposed by surgery. "This example illustrates that surgical procedures do nothing to alter the reinforcing properties of food for individuals with PWS" (p. 28).

Modification of Behavior Problems and Prader-Willi Syndrome

Individuals diagnosed with PWS emit a whole host of behavior that can be classified as problematic. Behavioral interventions aimed at reducing such problematic behavior are usually successful (Dykens et al., 1997; Page, Stanley, Richman, Deal & Iwata (1983); however, the lion's share of the research is devoted to weight reduction (Liquori, 1998). There are a few studies that discuss the use of behavioral procedures in the reduction of other target behaviors. Hoffman et al. (1992) surveyed numerous individuals with PWS and their caregivers. Based on their findings, they suggest implementing a point system and providing verbal praise contingent upon desired behavior. Edmonston (1982) found that when trying to get a young child with PWS to participate in speech therapy, "social reinforcement yielded only modest results" (p. 243), but the provision of food contingent upon compliance with demands was reportedly very successful. Carpenter (1989) reported the success of positive practice for the treatment of encopresis.

More systematic studies were conducted in the investigation of procedures to reduce food stealing. For example, Altman et al. (1978) used behavior contracts stipulating both reinforcement and punishment contingencies. The contracts imposed such punishing contingencies for food theft as requiring apologies to be made publicly, levying fines, sending the thief to bed early, and imposing privilege penalties. Special privileges were earned in the absence of contract infractions.

Page et al. (1983) implemented a differential reinforcement of other behavior schedules (DRO) to eliminate food stealing in conjunction with a token economy. Incidents of food-theft resulted in token fines (response cost). Alternatively, tokens were dispensed several times a day in the absence of food-theft. This procedure eliminated food stealing and generalized across three settings.

According to Liquori (1998), "Behavior modification and management strategies are presently regarded as an essential treatment component yet there have been few behavioral outcome studies of any kind applied to this population" (p. 5). Fortunately, this statement is no longer entirely true. What follows is an example of just that, a behavioral outcome study applied to a small segment of the PWS population. It remains in effect and successful until today.

CHAPTER 2
INTRODUCTION TO THE PRESENT STUDY

Individuals diagnosed with Prader-Willi syndrome (PWS) suffer from progressive, morbid obesity. Untreated, the health risks associated with PWS can be life-threatening. The morbidity and moribundity, however, of this syndrome can be attenuated with proper treatment. Any successful treatment must combine both strict dietary controls and an exercise program based on current individual levels of fitness. Unfortunately, the primary dependent variable of interest to most researchers working with this population is typically not exercise. Moreover, procedures reportedly aimed at increasing exercise among individuals with PWS are largely unsystematic, without structure, do not operationally define independent and dependent variables, and are primarily unsuccessful.

The purpose of this study is to determine the feasibility of developing and implementing an effective exercise program based on the behavior of the individual and using calories as reinforcers. Traditionally clinicians have relied on more conventional types of reinforcers when attempting to establish consistent compliance with exercise programs on the part of these patients. This study capitalizes on the magnitude of reinforcing properties of calories characteristically at great strength with this particular population. Further, no single-subject changing criterion studies currently exist in which exercise behavior is shaped and maintained using calories as reinforcers. The procedures described herein are simple and effective. The may be adopted readily by clinicians seeking to help others adhere to and benefit from a comprehensive exercise program.

Literature Review

Behavioral Outcome Studies: Weight Reduction and Exercise

Early studies focusing on the behavioral treatment of PWS were geared primarily toward weight reduction. The imposition of severe dietary restrictions (e.g., only 300 or 500 kcal. Per day) resulted in short-term weight loss; however, they were frequently unsuccessful in the long run. This was perhaps due in part to the fact that related behaviors such as incessant food seeking, foraging, stealing food, and avoidance of activity remained unchanged (Coplin, Hine, & Gormican, 1976; Liquori, 1998). Initial attempts to modify the maladaptive behavior emitted by PWS patients and reduce their weight did not utilize operant procedures explicitly but rather functioned predominantly to supplement the control exerted by staunch dietary restriction (Liquori, 1998).

Among the first researchers to develop a procedure that resulted in successful weight loss for children with PWS were Pipes and Holm (1973). After taking baseline data on daily caloric intake and weight, they developed individualized dietary prescriptions based on adjustments to daily caloric intake. Pipes and Holm (1973) also incorporated an education component for both caregivers, the four boys with PWS and their teachers and peers. They initiated a training element into the treatment package that included instruction on low calorie cooking. The authors attributed the success of the treatment package to tight environmental control, total family involvement, education, and training.

Thompson et al. (1980) also implemented strict calorie restrictions (e.g., zero kcal. per day increased to 750 kcal. per day raised in 250 kcal. increments) within the structure of an ongoing token economy and harsh punishment contingencies (e.g., social isolation and shock) and response cost for weight gain. The results of this study were equivocal. Descheemaeker et al. (1994), on the other hand, reported more positive results when children were taught to discriminate between low and high calorie food with different colored stickers. Children were then allowed to plan their own meals using this system. A system of rewards and less harsh punishment was implemented to help participants meet their weight goals. The system was in effect for an entire year and the authors reported that the results were positive (e.g., average weight loss of 2.25 kg.)

Treatment programs designed for individuals with PWS "are couched within an operating structure that is either implicitly or explicitly Skinnerian" (Liquori, 1998, p. 71). Procedures to reduce caloric intake are generally based on response cost (Thompson et al., 1980), token presentation contingent upon weight loss (Page et al., 1983), and other such systems of contingent reinforcement and punishment for weight loss or gain (Mullins & Vogl-Maier, 1987; Nardella, Sulzbacher, & Worthington-Roberts, 1983). Interestingly, "Few investigators have focused on results of exercise within Prader-Willi populations" (Silverthorn & Hornak, 1993, p. 656). Very few exercise outcome studies exist (Liquori, 1998) and of those published even fewer can be described as systematic.

Most of the studies that address exercise with PWS subjects are informal. Descriptions of procedures for designing and implementing exercise programs are often vague and frequently absent altogether (Caldwell, Taylor, & Bloom, 1986; Liquori, 1998; Mulins & Vogl-Maier, 1978; Page et al., 1983; Silverthorn & Hornak, 1993). For example, Page et al. (1983) implemented a nondescript token system characterized by "token award contingent upon walking, swimming, or stairclimbing" (p. 263). The participants in a study conducted by Silverthorn & Hornak (1993) "began a walking program of 6 months' duration, from October to April. They walked as a group on a level riverbank trail from 2 to 4 days per week, usually for longer periods on weekends" (p. 654). The authors provided very general group information on the length and duration of the walks.

The most thorough description of an exercise outcome study is that given by Liquori (1998). Liquori (1998) compared the effects of a traditional token economy (e.g., tokens supported by inedible items) to the effects of an alternative token economy (e.g., tokens supported by edible items) on measures of "clinical efficacy" (p. 126). These measures were determined rate of exercise, gross caloric expenditure, and cardiovascular exertion (e.g., exercise heart rate and THR or target heart rate). The laboratory assessment VO_2 max is considered to be the preferred method for determining maximal oxygen uptake (Liquori, 1998; Powers & Doss, 1996). The definition given for VO_2 max by Powers & Dodd (1996) is as follows:

> In simple terms, VO_2 max is a measure of the endurance capacity of both the cardiorespiratory system and exercising skeletal muscles. Because direct measurement of VO_2 max requires expensive laboratory equipment and is very time consuming, it is impractical for general use. (p. 20)

It is the maximum oxygen utilization during one minute of exercise. Thus, testing VO_2 max requires special equipment and expertise in assessment, and the costs are prohibitive. In lieu of laboratory VO_2 max tests applied researchers have frequently relied upon determining exercise heart rate given that a strong positive correlation exists between heart rate and oxygen consumption (Liquori, 1998; Powers & Dodd, 1996). For an extensive review of the benefits to determining heart rate and its relation to oxygen consumption and as an indicator of exercise intensity and effort the reader is referred to Liquori (1998) and Powers and Dodd (1996).

Liquori (1998) also addressed the issue of whether the guidelines (e.g., heart rate) set forth for normally developing individuals were relevant when designing exercise programs for individuals with PWS. Hatten (1994, as cited by Liquori, 1998), investigated this very issue by studying the relationship between heart rate and oxygen consumption in PWS subjects. Hatten (1994) found a "robust linear relationship . . . between oxygen consumption and heart rate" (Liquori, 1998, p. 98). This supports the use of measuring heart rate to predict VO_2 max with the PWS population. For a thorough description of the procedure employed by Hatten (1994) the reader is referred to Liquori (1998).

Liquori (1998) found that relative to baseline, the provision of tokens supported by inedible reinforcers resulted in higher exercise response rates, greater caloric expenditure, and cardiovascular benefits. Interestingly, the use of tokens supported by edible reinforcers did not result in greater increases in heart rate or calorie expenditure than the former token system. The researcher concluded that the data did not bear out the hypothesis that food is a more powerful reinforcer than tangible items for the PWS population. Liquori (1998) stated, "Future research may choose to explore whether larger amounts of food would have increased the utility of the alternative approach" (p. 177).

Controversial Use of Food as a Reinforcer

The issue of using food or calories as reinforcers with this population is a controversial one for several reasons. The first has to do with the anecdotal and ubiquitous assumption that individuals with PWS do not have food preferences. The second relates to the ethicality of manipulating caloric intake in general. The first assumption has been empirically proven to be false.

Contrary to popular belief, individuals with PWS do not eat indiscriminately. They do have food preferences, which remain consistent, as do the food preferences exhibited by normally developing individuals (Joseph et al., 2002). In 1983, Caldwell and Taylor were the first to definitively show that PWS patients do indeed demonstrate a consistent food preference and that preference appears to be "related to cognitive ability" (p. 48). Furthermore, they reported that when given a choice, "these subjects consistently chose a lesser amount of preferred food over a greater amount of nonpreferred food" (Caldwell & Taylor, 1983, p. 48). That participants consistently selected small portions of sweets over larger portions of foods rated as nonpreferred was supported by the findings of Taylor and Caldwell (1985).

Subsequent investigations also found that individuals with PWS demonstrate consistent food preferences (Caldwell et al., 1986; Fieldstone et al., 1997; Joseph et al., 2002). For example, Fieldstone et al. (1997) found that individuals with PWS consistently preferred foods high in carbohydrates to foods high in fat or protein. Joseph et al. (2002) indicated that quantity is an important determinant of choice when selections consist of computer-generated pictures backed up by the dispensation of the actual items. Participants tended to choose larger quantities of food when delays ranging from 15 to 60 seconds are imposed. Furthermore, this tendency was reduced when less preferred foods were provided.

Based on findings showing that individuals with PWS exhibit food preferences, Caldwell et al. (1986) sought to develop a less restrictive system for managing weight using preferred food items. "To be eligible to earn a reinforcer, a subject had to first complete all "required" exercises the previous day" (Caldwell et al., 1986, p. 349). They found that exercise activity increased to a greater extent, as measured by the number of "activity units" (p. 349) earned, when preferred food items were provided contingently compared to when activity units could only be exchanged for nonpreferential food items.

With respect to any concerns regarding the use of food in reinforcement procedures, Caldwell et al. (1986) stated the following:

> The use of food as a reinforcer has been considered taboo by those who use more conventional and restrictive management approaches with Prader-Willi syndrome individuals. Our data, however, strongly suggest that a low volume of food can be used as an effective reinforcer for increased activity and exercise. (p. 353)

Ethicality of Food Restriction

There is an escalating trend to increase community and patient involvement in the type of care and treatment PWS patients receive. However, there is much concern when dealing with patients such as those with PWS "for whom increased decision-making leads to unhealthy and even life-threatening consequences" (Dykens et al., 1997, p. 312). Some states have declared that locking up food, restricting environments, visitation, travel, and access to money is in direct violation of personal rights. Moreover, such restrictive control is believed to prevent behavior from coming under the control of natural contingencies. This has led to mandates for giving individuals with PWS more dietary control, less restrictive placements, and increasing the availability of food. As a result, "at least a dozen cases of deaths related to state policies and mandates to relax the food restrictions or living situations of clients with Prader-Willi syndrome have occurred" (Dykens et al., 1997, p. 312-313).

Occupational loss, pandering, criminal behavior and subsequent arrests and bodily injury while panhandling are also "natural consequences" (Dykens et al., 1997, p. 313) associated with food-seeking behavior. The appreciation of "unequivocal rules in treating hyperphagia in people with Prader-Willi syndrome" (Dykens et al., 1997, p. 313) can prevent tragedies from becoming an eventuality. The first rule is accepting the physiological underpinnings of hyperphagia rather than assuming that it is an issue of motivation. This places the locus of control squarely in the environment.

> As such, external controls are needed to curb obesity, such as locked food sources and close supervision. Though people can learn specific food techniques that are helpful to them, interventions should not rely solely on this learning or on strategies such as increasing willpower or self-control around food. (Dykens et al., 1997, p. 313)

The second rule is that hyperphagia does not remit. Therefore, lifelong food restrictions must be imposed. Loss of life may be prevented by appreciation of these two rules (Dykens et al., 1997).

Purpose of the Present Study

This study was designed to extend and refine previous exercise outcome studies that examined the effectiveness of exercise only informally. We sought to answer this experimental question:

> Can differential reinforcement procedures be used to generate and maintain a long duration operant (chronic aerobic exercise) using calories as reinforcers?

The present study departs from previous investigations in many ways. A discussion of some of the methodological differences between this study and that of the most recent outcome study conducted by Liquori (1998) is representative of the procedural improvements presently made.

Participants in this study were not participating in an exercise program nor had they reached their goal weights except for one participant. The subjects participating in the experiment conducted by Liquori (1998) were already complying with an exercise program coordinated and monitored by a "certified trained receptionist therapist (CTRS)" (p. 126). They were already exercising for a duration of 45 minutes and had already reached or were within a few pounds of their goal weight. Liquori did not provide any formal response definitions or response rate data and relied on the digitally displayed caloric expenditure data commonly provided with commercially marketed exercise equipment (e.g., stationary bicycle and dual action stair stepper). The data collection procedures employed in the present study were based on formal operational response definitions and data were collected independently from that displayed by the exercise equipment. The rationale for this independent data collection procedure and description of the data collection process are further described in the setting, apparatus, and response definitions section of chapter three.

The present study also extends the literature devoted to choice with the PWS population (Caldwell et al., 1986; Caldwell & Taylor, 1983; Fieldstone et al., 1997; Joseph et al., 2002; Taylor & Caldwell, 1986) in that for one individual the opportunity to choose between two alternative consequences was incorporated into an exercise program.

CHAPTER 3
MATERIALS AND METHODS

Participants

Six adults and one adolescent diagnosed with Prader-Willi Syndrome served as participants. These individuals were recruited from the Prader-Willi treatment program operated by the Association for Retarded Citizens (ARC) of Alachua County, Florida. Only individuals approved medically for participation by the Department of Pediatric Genetics at Shands Hospital were included. All subjects were on calorie-restricted diets and were experienced with daily recording of their own caloric intake. Each day started with an individualized calorie allotment that was recorded on a daily ledger (calorie sheet). Throughout the day participants documented all food items consumed on their calorie sheet and subtracted the caloric value of each item from their current calorie balance. The balance was not allowed to go below zero and any remaining calories at the end of the day were carried over and added to the next day's allotment. Two of the participants were males and five were females. Their ages ranged from 16 to 41 with the mean of 20.

Body weight was determined to be in excess of recommended ranges for all participants except one, and medical complications secondary to obesity were exhibited. In six of the seven cases, caregiver reports and medical documentation indicated that previous parental or professional attempts to control body weight were unsuccessful. Informed consent was obtained from each adult participant. For the adolescent, informed consent was obtained from her legal guardians as well as verbal assent from the adolescent herself. Thus, inclusion in the study was dependent upon physician approval regardless of age, diagnosis, weight, and consent.

Table 3-1 shows each participant's height in centimeters and body weight in pounds. Body weight is provided for both the beginning and the end of the present study.

Table 3-1. Participant demographic characteristics

Subject	Diagnosis	Height	Initial body weight	End body weight
Clara	Deletion positive	149.2 cm	518 lbs.	337 lbs.
Rita	Deletion positive	143.6 cm	156 lbs.	124 lbs.
Bobby	Deletion via Translocation	149.4 cm	210 lbs.	162 lbs.
Linda	Deletion positive	146.8 cm	271.5 lbs.	213 lbs.
Mary		150.7 cm	318.5 lbs.	250 lbs.
Cathy	Deletion positive	151.4 cm	101 lbs.	110 lbs.
William		145.2 cm	257 lbs.	250 lbs.

Note: Diagnosis deletion positive refers to the absence of paternally expressed genes on chromosome 15 as revealed by high-resolution molecular genetic analysis. Diagnosis via translocation refers to other chromosomal anomalies in which part of one chromosome breaks off and attaches to another chromosome.

The subjects who participated in this experiment reside in group homes in which access to food is tightly controlled. Daily caloric intake is closely observed, recorded, and controlled. A dietician affiliated with Shands Hospital and with expertise in PWS evaluates and helps determine daily dietary allotments for each individual and provides consultation regarding menu planning, meal preparation, and calorie exchange. All subjects had a history of preparing their daily calorie sheets and planning their meals and snacks from these sheets. Each day a menu was posted in the kitchen listing the food choices for that day, the portions of each selection and their caloric values. The residents choose from the menu and marked down the number of portions of each food item they desired, totaled the caloric cost, and then subtracted that cost from their daily caloric allotment.

Human Subjects Considerations

Institutional human subjects committee approval was obtained for conducting this study from the University of Florida Health Science Center. The approval covered all treatment procedures and assessment protocols, experimental design and conditions. The Institutional Review Board (IRB) number assigned to this study is 440-99.

Experimenters, Reliability, and Procedural Integrity

The research team consisted of the primary investigator, 14 undergraduate research assistants, and two PhD level supervisors. All observers received pretraining on data collection by the primary investigator and one of the PhD level supervisors. Subsequently, pairs of observers practiced the observation and recording procedures in other group homes on residents who were already exercising but not participating in this study. They were required to reach a criterion of 100% interobserver agreement (IOA) criterion for all dependent measures for three consecutive practice sessions before formal data collection began.

During data collection pretraining and formal data collection, a ratio method was used to assess percentage agreement for all measures, including pulse readings, across all conditions. Percentage agreement was computed by subtracting the smaller number from the larger number, dividing the result by the larger number, and multiplying the result by 100.

One observer was assigned to each participant as the primary observer. Another observer was paired with that primary observer. Each pair of observers collected data simultaneously and independently for at least 75% of all sessions. Agreement percentages are shown in Table 3-2.

To check the possibility of the occurrence of procedural drift (e.g., observers have gradually changed their criteria for scoring subject performance), procedural integrity

Table 3-2. Percentage agreement

Participant	Resting pulse		Exercise pulse		Number responses		Response rate	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Clara	95%	84%-100%	95%	76%-100%	95%	68%-100%	99%	83%-100%
Rita	97%	82%-100%	96%	73%-100%	98%	63%-100%	98%	63%-100%
Bobby	96%	83%-100%	96%	72%-100%	99%	84%-100%	99%	84%-100%
Linda	99%	88%-100%	96%	85%-100%	98%	83%-100%	97%	33%-100%
Mary	98%	84%-100%	94%	91%-100%	99%	91%-100%	99%	93%-100%
Cathy	99%	90%-100%	96%	85%-100%	98%	75%-100%	98%	74%-100%
William	99%	97%-100%	99%	91%-100%	95%	63%-100%	94%	55%-100%

was assessed within and across sessions and subjects. The primary investigator, a PhD level supervisor, and primary observers monitored the implementation of 10% of exercise sessions for another observer. An example of the procedural integrity assessment tool is provided in Appendix A. Thirteen experimenter behaviors were monitored and scored as either correct or incorrect. These behaviors are the provision of appropriate instructions (scored correct 98% to 100% of sessions), inclusion of additional instructions (scored correct 99% to 100% of sessions), omission of instructions (scored correct 99% to 100% of sessions), speaking to the participant during a session (scored correct 97% to 100% of sessions), ignoring participant commentary during sessions (scored correct 96% to 100% of sessions), maintaining an appropriate distance from an exercising participant (scored correct 99% to 100% of sessions), appropriate implementation of the reinforcement procedure (scored correct 99% to 100% of session), recording data on all dependent measures (scored correct 98% of time until 100% of sessions), placing the exercise equipment at the proper setting (scored correct 99% to 100% of sessions), providing the participant with the appropriate discriminative stimulus (scored correct 98% to 100% of sessions), professional conduct (scored correct 100% of sessions), avoiding eye contact with an exercising participant (scored 99% to 100% of sessions), and following the experiment protocol (scored correct 98% to 100% of sessions).

Consumer and Staff Satisfaction Surveys

Subjective evaluation measures of outcomes (e.g., questionnaires and interviews with participants, staff and family members) were collected both before and after formal data collection (Appendices B and C). Subjective evaluations indicated that participants, caregivers, and ARC staff persons were very satisfied with the exercise program.

Participants' attitudes toward exercise (e.g., importance of exercise) improved pre-to-post experiment assessment.

Participant Safety Safeguards and Medical Oversight

Given that persons diagnosed with PWS are characterized by life-threatening obesity, a procedure that is successful in helping them reduce their weight and increase their activity level may aid in reducing associated health risks. The anticipated health risks associated with this experiment were not perceived to be any greater than those encountered by any individual beginning an exercise program. However, due to the extreme obesity evidenced by some participants their personal physician, a PhD level supervisor, and a nutritionist with expertise in PWS periodically monitored the total number of calories earned, heart rate, physical well being, and weight loss throughout this study. Likewise, they also monitored type of exercise, intensity, and exercise duration. Dr. Dan Driscoll, Department of Pediatrics, Division of Genetics at Shands Hospital, University of Florida, also provided additional medical oversight to minimize potential risks to participants.

Setting, Apparatus, and Response Definitions

All experimental sessions were conducted in participants' residential group homes at approximately the same time each day. Each group home has an exercise room that is equipped with exercise equipment owned by the residents. This equipment consists of Lifefitness ™ stationary bicycles and treadmills. Participants were given a choice of riding a bicycle or walking a treadmill prior to formal data collection. All but two individuals chose to use their own exercise equipment. The remaining two participants chose to use the treadmill of a fellow resident. The owner gave permission for use of the treadmill.

In one case, the individual chose the treadmill; but, her body mass and resultant slow, awkward gait precluded safe treadmill use, so she initially walked laps of a predetermined 25-foot measured section of bare floor inside the home. The section of floor was marked off with masking tape to provide accurate measurement. Eventually, she was able to walk safely on the treadmill when her weight was reduced by over 100 pounds.

For participants riding the stationary bicycle, each complete revolution of the pair of pedals was counted as a single response. Electronic Redington Counters®, model number D2-4906, which were wired to SPDT submini roller lever switches by Radio Shack® counted responses automatically. The switches were fastened to 1.5 in. x 5.5 in. x .5 in. wood mounts. The wood mounts were attached to the stationary bicycles at the pedal well. They were centered vertically at twelve o'clock. Each time a revolution of the pedal was executed, the pedal tripped the roller lever switch and registered on the electronic counter.

Participants for whom walking (treadmill or floor) was the target exercise, a step was defined as a complete movement cycle of each foot in a heel-to-toe motion executed flatly on the walking surface. Each step of each foot was counted using hand-held digital tally counters. The counters were Model 385 manufactured by Sportline®. The researchers determined duration of time spent exercising independently from the equipment instrumentation by using handheld stopwatch timers. These stopwatch timers were also used when determining resting and exercise heart rate. Duration of exercise was also monitored by the participants themselves through observation of the timer on the display panel of the exercise equipment.

The weight of each participant was also recorded periodically throughout the experiment. Each individual weighing less than 300 pounds was weighed on a daily basis. Using Health-O-Meter™ medical balance scales, each participant was weighed at approximately the same time every morning. The scales were calibrated each week with a 10-pound weight. The two individuals weighing over 300 pounds was weighed weekly on a special freight scale.

The primary dependent variables were rate, frequency, duration, and intensity of exercise. Rate of exercise is the number of responses the participant emits per minute such as steps or pedal rotations per minute. Frequency refers to how many days a week the participants exercised and met their exercise criteria. Duration is the amount of time spent engaging in exercise behavior from onset to offset of activity. In the present study, intensity refers to equipment settings for level of difficulty or response rate. These variables are directly related to how hard an individual is working.

Intensity is also measured by checking heart rate while an individual is engaging in exercise activity, "this has become the standard means of determining exercise intensity" (Powers & Dodd, 1996, p. 81). Exercise heart rate and heart rate at rest are important indices of fitness. They also anchor compliance with safety guidelines (Anspaugh, Hamrick, & Rosto, 1997; Powers & Dodd, 1996).

The standard method for determining heart rate is at the location of the radial artery. Researchers took pulse by placing the index and middle finger of their preferred hand on the wrist of the participant. Rate of pulse at the radial artery is taken at the location of the wrist directly behind the individual's thumb with their palm faced up. This site for palpation is preferred over the carotid artery location (Anspaugh et al., 1997). According to Anspaugh et al. excessive pressure at the carotid artery "stimulates specialized receptors that automatically slow the heart rate, leading to an underestimation of the rate actually achieved during exercise" (p. 66). Additionally, we found that taking the pulse rate at this location was negligible with these particular subjects. Excessive body mass in the neck region completely precluded pulse palpation.

Resting heart rate in beats per minute was obtained after the participant had sat completely still in a chair without speaking for 5 consecutive minutes. Pulse was then taken for a full 60 seconds. Subsequent to the cessation of exercise, pulse was immediately taken again determining exercise heart rate. This was accomplished by counting each heart beat for a duration of 10 seconds and then multiplying the result by 6 (Anspaugh et al., 1997).

The target heart rate (THR) was also determined for each participant. This rate informs us as to whether or not the individual is exercising at such an intensity or rate to improve their overall fitness level and health. These calculations also allow us to calculate the "training-sensitive zone" for each individual (Powers & Dodd, 1996, p. 85). "This method works on the principle that exercise intensity (i.e., % VO_2 Max) can be estimated by measurement of exercise heart rate" (Powers & Dodd, 1996, p. 84). This method employs a standard formula that requires subtracting the participants' age from 220 to yield the maximal heart rate. This figure is then multiplied by .70 and .90 to determine the end points of the THR range.

Total and rate of calorie expenditure, miles walked or ridden, and weight were also variables of interest. The number of total calories burned and rate of calorie expenditure as well as total number of steps taken, or pedal rotations, and total number of miles walked or ridden were either counted independently or derived mathematically because these data were either not provided by the exercise equipment or were unreliable gross approximations of the actual measures. Preliminary tests of the exercise equipment with researchers serving as exercise participants showed that the postexercise information (e.g., miles ridden on the stationary bicycle or walked on the treadmill, total caloric expenditure) registered on the equipment LED display panel was highly variable and approximate when exercise rate and intensity were held constant. Consultation with the manufacturer confirmed this. Therefore, it was decided to determine mathematically how many miles were accrued and accompanying caloric expenditure from total number of steps and pedal rotations, rather than relying on the equipment readout.

These basic and directly measured data provided the fundamental numerical variables from which the necessary mathematical calculations could be made. The consumer division of the manufacturer, Lifefitness® in Ramsey Minnesota, provided the formulas for these calculations (American College of Sports Medicine, 1991). The formulas for and examples of these calculations are provided in Appendix D (Lifefitness. Com).

Experimental Design

The experimental design employed was the single-subject changing criterion. One of the advantages of this design is its effectiveness when shaping target behavior (Hartmann & Hall, 1976; Johnston & Pennypacker, 1980). According to De Luca and Holborn (1992), when "using a changing-criterion design, the initial criterion is based on the subject's own baseline performance and is increased via small, successive increments. In this manner, high rates of exercise can be approached gradually and systematically" (p.671). The changing-criterion design fits well with the "Principle of

Progression" (Powers & Dodd, 1996, p. 64), which stipulates that exercise intensity or duration should be increased gradually (Anspaugh et al., 1997). The changing-criterion design's key characteristic of stepwise changes in behavior (Hartmann & Hall, 1976) suits this study well given the goal of gradual stepwise changes in behavior.

Experimental Sequence

The primary sequences of experimental conditions were as follows: (a) baseline; (b) verbal prompt condition; (c) differential reinforcement of duration condition; and (d) differential reinforcement of intensity condition. The verbal prompt and differential reinforcement conditions were comprised of different subphases that corresponded to the stepwise gradual changes approximating individual target goals. Decisions and guidelines for the duration of conditions and specification of goals and changes for each subphase were based upon the consensus of the research team as they examined the current data.

Prior to the onset of the experiment, the Rockport Walk One-Mile Fitness Test was given to all participants to determine their current level of fitness. This test was chosen because it is recommended for sedentary individuals (Anspaugh et al., 1997; Powers & Dodd, 1996). It consisted of enjoining participants to walk around a 440-yard track at the YMCA four times. Participants were paired with a research assistant or experimenter. The distance and duration each individual walked was recorded. Participants were instructed to walk as fast as they could. They were encouraged to walk for an entire mile but allowed to stop at any time with the test thereby terminated. No programmed consequences were in place for either completion or failure to complete the test. Baseline sessions began after all participants either took this test or refused to do so.

Baseline. Baseline data were collected for all participants for at least three target days (Monday, Wednesday, and Friday)—the equivalent of one week. Participants were observed directly and continuously each day from the time they returned to their residences from either work or school until dinner was served. This time interval represents the free time interval for residents to engage in exercise activity. This is also the scheduled time frame during which other group home residents exercised. Exercise equipment was present and freely available at all times. Participants were not asked to exercise and no contingencies were in place for exercising. If a participant did exercise, data on the dependent variables were recorded. The procedures for initiating exercise sessions including the instructions given to the participants are provided in Appendix E.

Verbal prompt condition. Following baseline, the treatment conditions were initiated on target days (Mondays, Wednesdays, and Fridays). The decision to conduct experimental sessions three target days per week was based on an exercise regime suggested by Powers and Dodd (1996) for people in the very poor fitness category. Specifically, an exercise frequency of three times per week is recommended. The first treatment condition was the verbal prompt condition. This condition was designed to determine the extent to which exercise behavior could be maintained by verbal prompting alone.

During the verbal-prompt-only condition, participants were asked if they wanted to exercise at the beginning of a session. Experimental sessions were initiated at the same time each target day. They began with the research providing the subject with the following verbal prompt: “Do you want to exercise today?” No consequences were in place for exercising or refusal to exercise. If the participant refused to exercise (i.e., verbally stated they would not exercise and did not initiate exercise within one minute), the refusal was recorded and the researcher left. For individuals who exercised when verbally prompted, the median duration exercise time was the starting point for subsequent duration verbal prompts or subphases during the verbal prompt condition. For example, if an individual was consistently exercising for about five minutes, then a subsequent verbal prompt five-minute condition was initiated. The participant was simply asked "Do you want to exercise for five minutes today?" Again, no consequences were in effect. If the individual exercised consistently, for at least 3 target days, for at least 5 minutes, new verbal-prompt duration subphases were initiated. For example, this individual might be asked if he or she wants to exercise for 7 minutes. The slow progression of exercise duration criterion was based on individual median performances in conjunction with recommendations by Powers & Dodd (1996).

The implementation of successive verbal prompt subphases was continued until one of the following happened: (a) the participant refused for at least 3 target days, (b) the 45-minute duration and THR goals were reached with only verbal duration prompts, (c) or previously stable performance under the verbal prompt only condition deteriorated.

For one participant, 45-minute durations of exercise were maintained under the verbal prompt condition. In this case, the verbal prompt condition was extended across numerous subphases over which the intensity of exercise was successively increased. Increases in intensity consisted of raising the speed or incline settings of the treadmill. Intensity subphases within this condition were designed to reach optimal exercise intensity slowly and progressively.

Differential reinforcement of duration. Systematic differential reinforcement of exercise duration using calories as reinforcers was initiated in a second treatment condition. This condition consisted of numerous subphases individually designed to help participants systematically increase the time in which they exercise. At each subphase, they were required to exercise for a specific duration that was increased for all subsequent subphases. Increases in duration were based on the median duration of the previous condition and did not exceed those recommended by Powers & Dodd (1996). For example they advocate exercising for only 10 minutes, three times per week during the first 2 weeks of an exercise program for individuals considered to be in poor or very poor physical condition. Compliance with duration requirements in this condition resulted in participants earning 100 "incentive" calories. Except where otherwise indicated, throughout the study earned calories were delivered by asking the participant for their calorie sheet and adding the calories to their current calorie balance on the sheet. Participants were provided with the following instructions: "[Subject's name], you are required to ride the bicycle (or walk on the treadmill) for __ minutes in order to earn ___ calories. Do you want to exercise today? Please begin." Stopping during the session resulted in termination of the session and the opportunity to earn calories was forfeited. Getting off of the exercise equipment or ceasing to emit any exercise behavior (e.g., pedaling or taking steps) for 5 seconds or longer constituted stopping. When the duration criterion was met, the researcher added 100 calories to the participant's daily calorie sheet.

Each new duration subphase within the differential reinforcement of duration using calories as reinforcers (treatment condition two) was initiated only if the individual had been in the preceding subphase for at least 3 target days. Also, exercise criteria must have been met for 80% of the sessions in that subphase (e.g., 4 out of 5 days). Additionally, exercise duration criteria must have been met on the last target day before a new phase or criteria change was initiated.

Differential reinforcement of intensity. The third treatment condition was characterized by the initiation of another differential reinforcement procedure if necessary. This condition was initiated if, once the 45-minute duration criteria was reached, participants were still not exercising at an intensity level sufficient to raise their heart rate to the training sensitive zone (THR). The primary goal of this condition was for participants to comply with increasing intensity requirements exercising in their target heart rate zone.

During this treatment condition, participants were required to increase systematically the number of responses or equipment setting (e.g., speed, incline, difficulty level) necessary to gradually elevate intensity of exercise. Subphases within this condition were designed on an individual basis to reach optimal exercise intensity slowly and progressively. Calories were added to individual's daily calories sheets contingent upon meeting their exercise criterion, duration and intensity, for the exercise session.

Once exercise performance was stable at the optimal intensity and 45-minute duration criterion on target days (90% participation or 9 out of 10 days), the Rockport Walk One-Mile Fitness Test was administered again. The administration and supervision of the exercise program was then turned over to the staff. Group home staff persons were trained throughout this study to continue the implementation of this exercise program.

Individualized Manipulations

Given that the experimental conditions arranged in this experiment were based on the behavior of the individuals and on specific behavioral objectives, it was necessary to deviate from the general procedure in some cases. When the general experimental procedure was deemed insufficient to change or maintain target behavior, changes were initiated. One change was providing a brightly colored calorie coupon for the amount of calories earned immediately after the exercise session was met. This provided the participant with an immediate and tangible reinforcer. The coupon could later be exchanged for the caloric face value of the coupon. Additionally, the caloric face value of the coupon was also subject to change.

Another change involved choice. One participant, for whom candy was a preferred food item (as determined by consensus opinion of the participant and a staff person familiar with that participant), was given the choice of a calorie coupon of differing caloric face values or candy (100 kcal.). The candy was given to the participant immediately once the exercise criteria were met. Again, the coupon could be exchanged later for the caloric face value of the coupon. The caloric value of the candy remained the same while the caloric face value of the coupon varied across conditions. These augmentations to the general experimental method were in effect until the goal of the study was reached for these participants as well—stable performance (e.g., exercising continuously 9 out of 10 target days with exercise heart rate in the training-sensitive zone or THR). Additional details of these individualized manipulations will be provided in the Results section.

Once *all* participants reached their THR and were consistently exercising, participation the experiment proper was discontinued. The terminal condition however remained in effect. The participants were still receiving calories for engaging in specific exercise behavior at a specific intensity on Mondays, Wednesdays, and Fridays. In addition, they now could receive calories for exercising on other days as well. On remaining weekdays, they now received calories based on engaging in *any* continuous exercise activity of their choosing (e.g., swimming, walking in the park) at any intensity level for a duration of 45 minutes.

CHAPTER 4
RESULTS

The results are presented in seven sections or one for each participant. All participants reached the 45-minute duration criterion exercising with their heart rate in their target heart rate zones (THR). In most cases, the average total caloric expenditure exceeded that of the amount of calories given as reinforcers when participants met these criteria. The provision of calories contingent upon emitting exercise behavior that satisfied the predetermined criteria was necessary to produce these changes for all but one participant. Three participants, Rita, Clara, and Bobby, selected walking as their preferred exercise activity. Their data are presented first.

Results for Rita

Baseline

The results for Rita are presented in Figures 4-1 through 4-4. Phase changes for Rita are summarized in Table 4-1. Figure 4-1 shows the duration of exercise across all phases for each consecutive session. Rita exercised for 0% of the sessions during baseline. This absence of any exercise behavior is characteristic of all of the participants in this study. Rita's average resting heart rate during baseline was 72 beats per minute (bpm). Figure 4-3 shows resting and exercise pulse rate or beats per minute.

Verbal Prompt Condition

During the verbal prompt condition, Rita exercised for median of 3.6 minutes. Subsequent verbal prompts subphases were initiated with a verbal prompt for her to

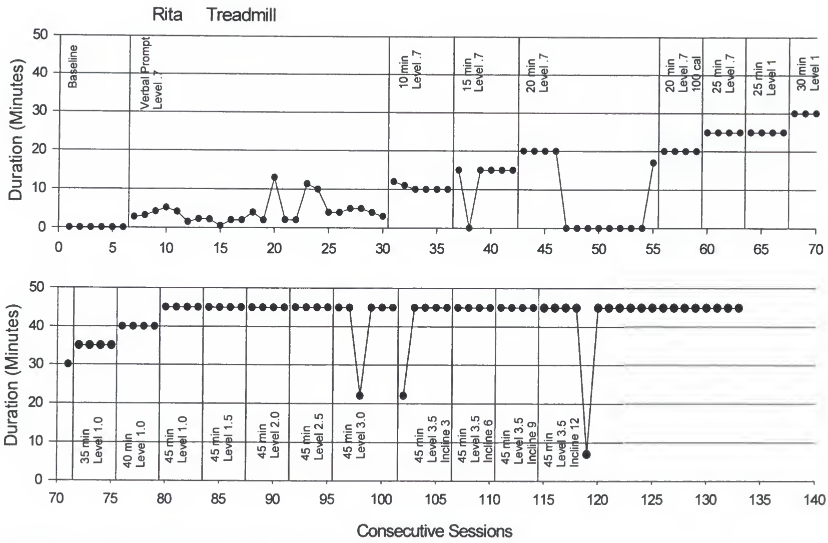

Figure 4-1. Exercise duration across conditions for Rita.

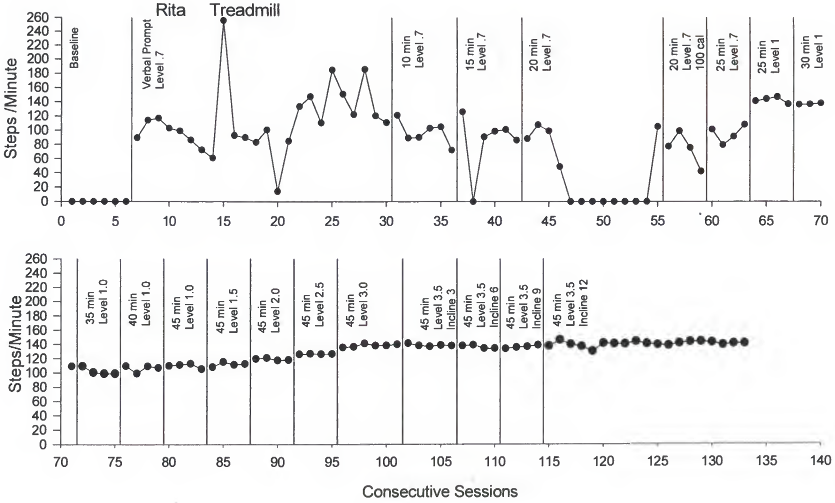

Figure 4-2. Steps per minute across phases for Rita.

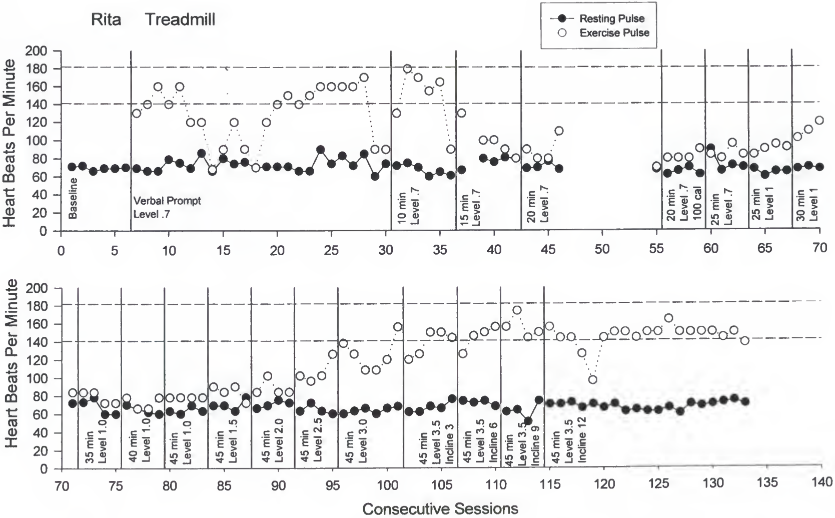

Figure 4-3. Heart beats per minute across phases for Rita. Filled circles show resting pulse rate and open circles show exercise pulse rate. Dashed horizontal lines show the target exercise heart rate zone.

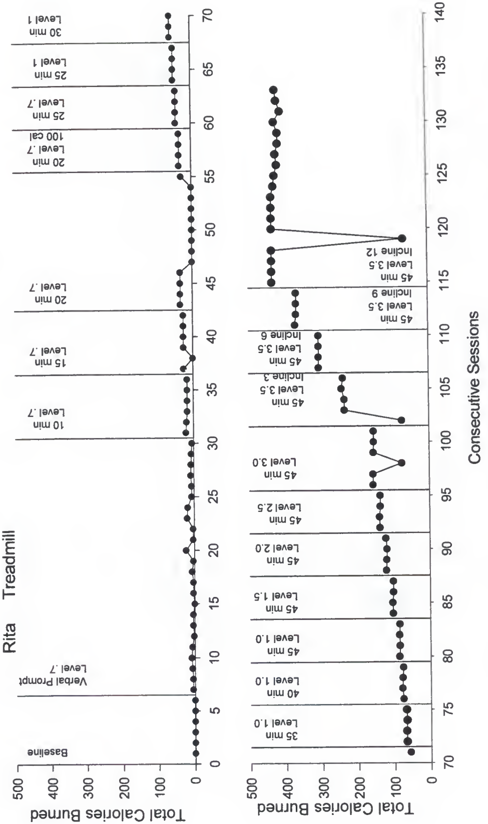

Figure 4-4. Total calories burned across phases for Rita.

Table 4-1 Phase change summaries for Rita

Baseline
Verbal prompt at level .7
Verbal prompt 10 min. at level .7
Verbal prompt 15 min. at level .7
Verbal Prompt 20 min. at level .7
Earn 100 kcal. 20 min. at level .7
Earn 100 kcal. 25 min. at level .7
Earn 100 kcal. 25 min. at level 1
Earn 100 kcal. 30 min. at level 1
Earn 100 kcal. 35 min. at level 1
Earn 100 kcal. 40 min. at level 1
Earn 100 kcal. 45 min. at level 1
Earn 100 kcal. 45 min. at level 1.5
Earn 100 kcal. 45 min. at level 2
Earn 100 kcal. 45 min. at level 2.5
Earn 100 kcal. 45 min. at level 3.0
Earn 100 kcal. 45 min. at level 3.5 & Incline 3
Earn 100 kcal. 45 min. at level 3.5 & Incline 6
Earn 100 kcal. 45 min. at level 3.5 & Incline 9
Earn 100 kcal. 45 min. at level 3.5 & Incline 12

exercise for 10 minutes. The 10-minute criterion was chosen because Rita stated that she wanted to walk on the treadmill for ten minutes. Given that the 10-minute duration was well within the guidelines stipulated by Powers and Doss (1996), the next sequence of subphases began with 10-minute verbal prompts.

The duration of time Rita walked on the treadmill increased during the verbal prompt condition from 10 to 20 minutes at the lowest treadmill speed .07 mph until performance dropped off to the baseline level. Figure 4-2 shows response rate or the number of steps Rita emitted per minute for each consecutive session. The range of responses per minute across all subphases in the verbal prompt condition ranged from 0 per minute to 256 per minute (M = 86.3 steps per minute). Rita's average exercise heart rate was 119.3 bpm and average resting heart rate was 72 bpm. Figure 4-4 shows total calorie expenditure per session. During the verbal prompt condition, Rita's calorie expenditure ranged from 0 to 30 total calories per session (M= 10.1).

Differential Reinforcement of Duration and Intensity

The next series of phase changes began with the addition of calories contingent upon exercising continuously for 20 minutes at .07 mph, the lowest speed setting. Her duration criterion was subsequently increased from 20 to 25 minutes at the lowest speed setting of .07 mph across subphases. The equipment speed setting was changed from .07 to speed level 1 mph in an attempt to gradually increase Rita's exercise rate to approximate her target heart range (THR). Over the next four subsequent phase changes, the duration criterion was systematically increased by five minute increments while the equipment speed setting remained constant at speed level 1 mph until Rita reached the 45-minute duration goal.

Although Rita met the 45-minute duration goal, her heart rate still was not within her THR zone. Thus, the next sets of subphases were designed to increase her heart rate to THR. The treadmill speed was increased incrementally from level 1 to 3.5 mph. Rita's physical restrictions precluded increasing the speed setting beyond 3.5 mph. Rather than increase the speed any further, we systematically increased the degree of incline from 3 degrees to 12 degrees over the next four subphases. Rita was consistently exercising for 45 minutes with her exercising heart rate in her THR zone at speed setting 3.5 mph with a 12-degree incline.

Figure 4-3 shows the resting and exercise heart rate across all phases for each consecutive session. Rita's resting heart rate ranged from 60 bpm to 90 bpm (M= 67.6 bpm) across all conditions. From the verbal prompt condition to the final phase of the experiment, her resting heart rate decreased by an average of 20 bpm. The reduction in resting heart rate is an indicator of increased cardiorespiratory fitness (Anspaugh et al., 1997; Powers & Dodd, 1996). Her exercise heart rate ranged from 68 bpm to 190 bpm across all conditions (M = 115.5 bpm). The range of responses per minute across all subphases is presented in Figure 4-2. This figures shows that in the differential reinforcement condition, responses ranged from 42.4 per minute to 148 per minute (M = 127.6 steps per minute). Figure 4-4 shows that caloric expenditure ranged from 0 to 433 total calories per session (M = 138.5).

Results for Clara

Clara was not able to walk on the treadmill due to her weight (518 lbs.), therefore, it was necessary to find an alternative for her. Since the results of the Rockport Fitness Test indicated that she was able to walk 25 feet, we found a hallway in the group home residence approximating that length. The hallway was a good initial choice because it had walls on either side. Given her weight and problematic gait, the walls provided some safety. She was able to steady herself against the hall walls when she lost her balance. The 25-foot length of hallway was taped-off with masking tape and instead of walking on the treadmill, Clara walked laps of this strip.

Baseline

The results for Clara are presented in Figures 4-5 through 4-8. Phase changes for Clara are summarized in Table 4-2. Figure 4-5 shows the duration of exercise across all phases for each consecutive session. Clara exercised for 0% of the sessions during baseline. Her average resting heart rate during baseline was 160 beats per minute (bpm). Figure 4-7 shows Clara's resting and exercise heart rate.

Verbal Prompt Condition

During the verbal prompt condition, Clara's range of steps per minute was 0 to 79 (M=54.). Figure 4-6 shows response rate for each consecutive session. Clara's average exercise heart rate was 157.6 bpm and average resting heart rate was 138.4 (Figure 4-7).

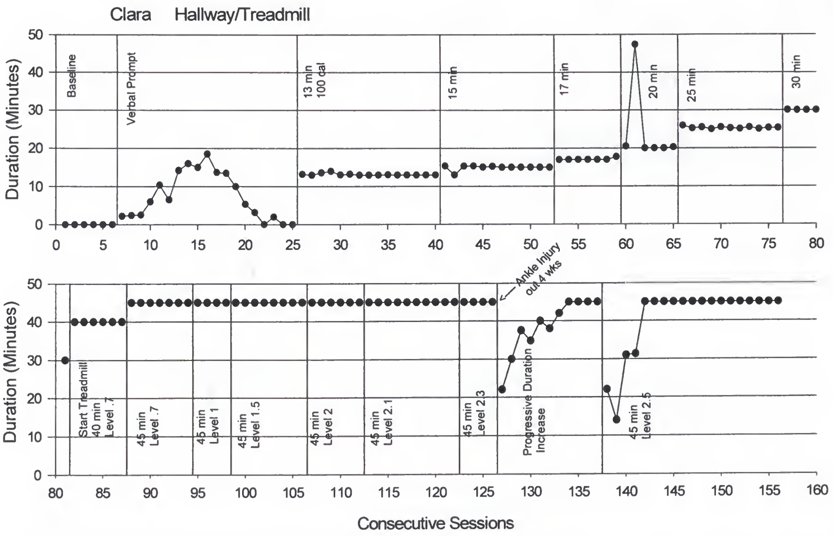

Figure 4-5. Exercise duration across conditions for Clara.

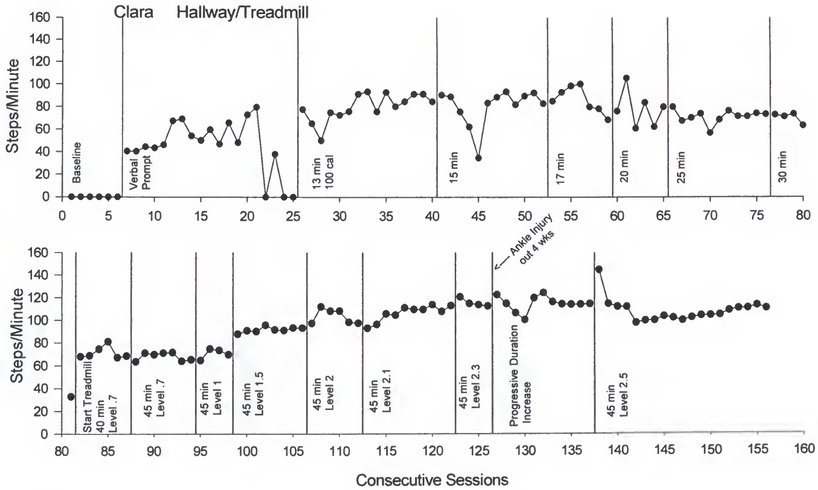

Figure 4-6. Steps per minute across phases for Clara.

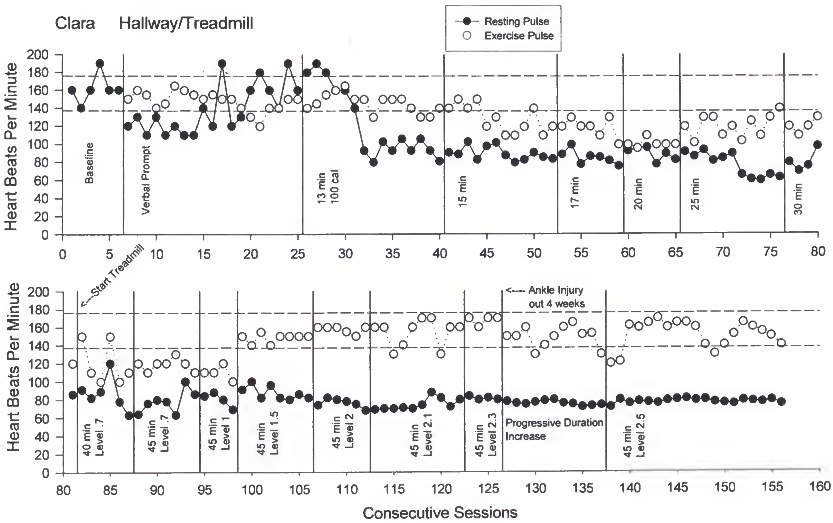

Figure 4-7. Heart beats per minute across phases for Clara. Filled circles show resting pulse rate and open circles show exercise pulse rate. Dashed horizontal lines show the target exercise heart rate zone.

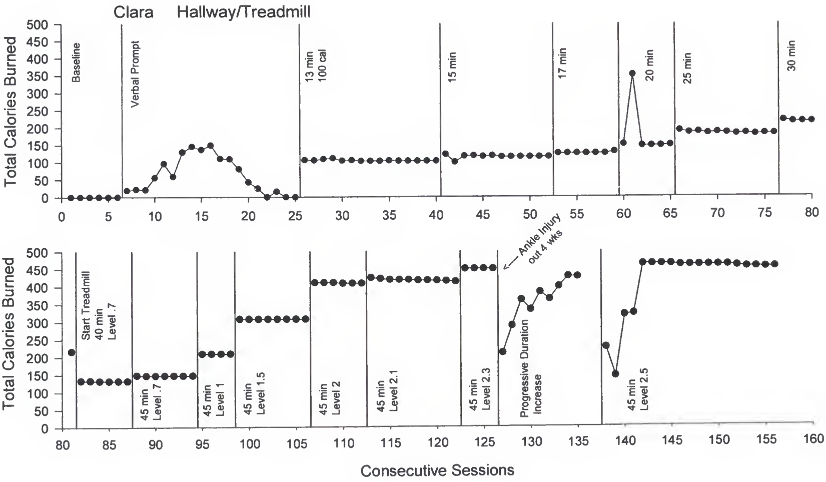

Figure 4-8. Total calories burned across phases for Clara.

Table 4-2. Table 4- 2 Phase change summaries for Clara

Verbal prompt
13 min. earn 100 kcal. laps
15 min. earn 100 kcal. laps
17 min. earn 100 kcal. laps
20 min. earn 100 kcal. laps
25 min. earn 100 kcal. laps
30 min. earn 100 kcal. laps
40 min. earn 100 kcal.-level .7 treadmill
45 min. earn 100 kcal.-level .7 treadmill
45 min. earn 100 kcal.-level 1 treadmill
45 min. earn 100 kcal.-level 2.0 treadmill
45 min earn 100 kcal.-level 2.1 treadmill
45 min earn 100 kcal.-level 2.3 treadmill
45 min. earn 100 kcal.-level 2.5 treadmill

Figure 4-8 shows total calorie expenditure per session. During the verbal prompt condition, Clara's total calorie expenditure per session ranged from 0 to 150 (M= 76.4). Clara walked the hall for a median of six minutes (M=7.5 min.) before performance dropped to zero. We were very concerned about this participant given her morbid obesity, so one of our goals was to get Clara to exercise as soon as possible within the safety guidelines. Since she had walked for the duration of 13 minutes or more seven out of 19 sessions during the verbal prompt condition, we decided to begin the differential reinforcement of duration phase with a 13-minute duration criterion.

Differential Reinforcement of Duration and Intensity

The next series of phase changes began with the addition of calories contingent upon exercising continuously for 13 minutes. The duration for reinforcement was systematically raised across subsequent subphases. By the time Clara was walking for 40 consecutive minutes she had lost 100 lbs. She was then able to begin walking on the treadmill with the speed setting on the lowest level (.7 mph.). Clara reached the

45-minute duration criterion while walking on the treadmill; however, her exercise heart rate was still below her THR zone. The next set of subphases raised the intensity criterion while keeping the duration requirement constant at 45 minutes.

Clara fractured her ankle during the 45-minute 2.3 mph. subphase that kept her from exercising for 4 weeks. When Clara resumed walking on the treadmill, she did not meet her duration criterion for seven sessions; however, the time in which she exercised increased progressively until she was soon meeting her duration criterion again. Clara met both her duration and heart rate criteria when the speed setting was raised to 2.5 mph.

Figure 4-7 shows that her resting and exercise heart rate across all differential reinforcement conditions ranged from 60 to 192 resting bpm (M= 119.6) and 102 to 170 exercising bpm (M= 166.7). The reduction in her average resting heart rate from the verbal prompt condition to the differential reinforcement condition was 19 bpm. Clara's range of responses per minute ranged from 34 to 144 across all subphases in this condition (M= 89.5). Calorie expenditure ranged from 0 to 460 (M= 249.7).

Results for Bobby

Baseline

The results for Bobby are presented in Figures 4-9 through 4-12. Phase changes for Bobby are summarized in Table 4-3. Figure 4-9 shows the duration of exercise across all phases for each consecutive session. Bobby exercised for 0% of the sessions during baseline. Bobby's average resting heart rate during baseline was 62.7 beats per minute (bpm). Figure 4-11 shows resting and exercise pulse rate or beats per minute.

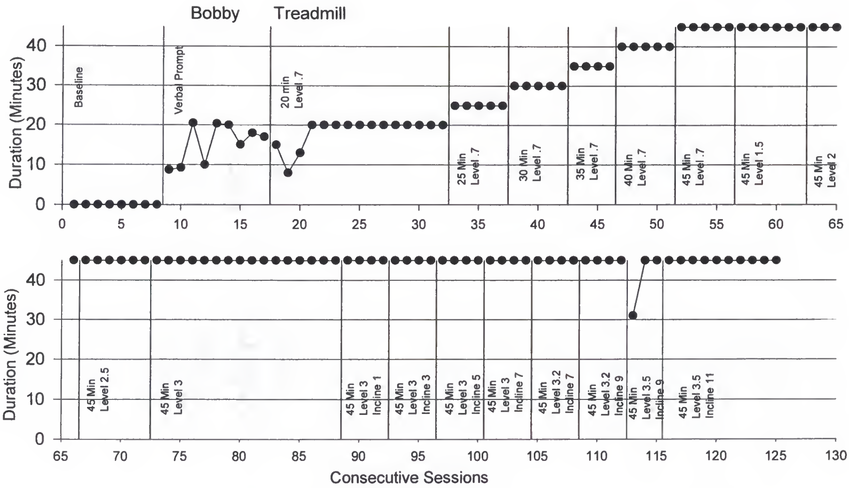

Figure 4-9. Exercise duration across conditions for Bobby.

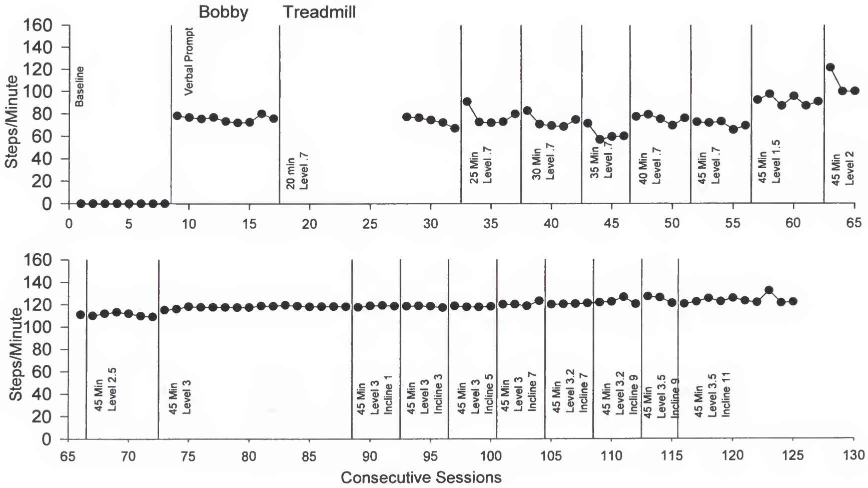

Figure 4-10. Steps per minute across phases for Bobby.

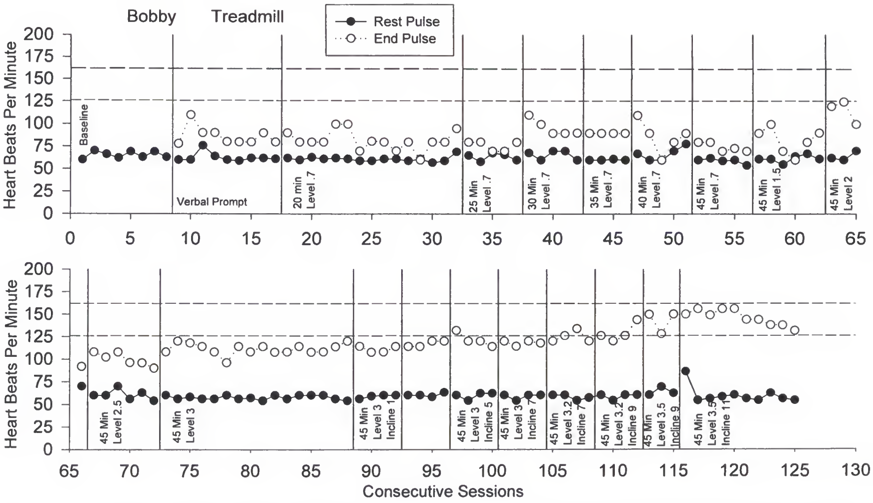

Figure 4-11. Heart beats per minute across phases for Bobby. Filled circles show resting pulse rate and open circles show exercise pulse rate. Dashed horizontal lines show target exercise heart rate zone.

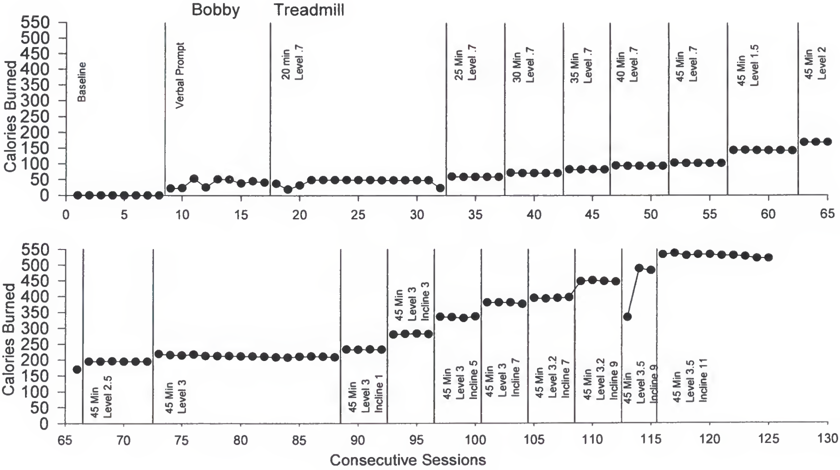

Figure 4-12. Total calories burned across phases for Bobby.

Table 4- 3. Phase change summaries for Bobby

Phase change
Baseline
Verbal prompt level .7
Verbal prompt 20 minutes level .7
Verbal prompt 25 minutes level .7
Verbal prompt 30 minutes level .7
Verbal prompt 35 minutes level .7
Verbal prompt 40 minutes level .7
Verbal prompt 45 minutes level .7
Verbal prompt 45 minutes level 1.5
Verbal prompt 45 minutes level 2.0
Verbal prompt 45 minutes level 2.5
Verbal prompt 45 minutes level 3
Verbal prompt 45 minutes level 3 incline 1
Verbal prompt 45 minutes level 3 incline 3
Verbal prompt 45 minutes level 3 incline 5
Verbal prompt 45 minutes level 3 incline 7
Verbal prompt 45 minutes level 3.2 incline 7
Verbal prompt 45 minutes level 3.2 incline 9
Verbal prompt 45 minutes level 3.5 incline 9
Verbal prompt 45 minutes level 3.5 incline 11

Verbal Prompt Condition

During the first verbal prompt condition, Bobby exercised for a median of 20 minutes. Given that Bobby was exercising consistently in the absence of any programmed contingencies, a sequence of verbal prompt duration subphases were initiated to approximate the 45 minute and THR goals. Bobby met the 45-miunute duration criteria with the treadmill set at the lowest speed level (.7 mph), however he was not exercising with his heart rate within his training sensitive zone (THR).

The speed level and incline of the treadmill were systematically increased across the next series of subphases within the verbal prompt condition. The duration criteria remained constant at 45-minutes. Bobby was consistently exercising with his heart rate in his THR during the final verbal prompt subphase (45-minute duration, speed level 3.5 mph, treadmill incline 11 degrees) in the absence of any programmed contingencies (e.g., the provision of calories contingent upon prescribed exercise).

Bobby's steps per minute ranged from 57 to 144 (M=101.8) across the verbal prompt subphases. His average resting and exercise heart rate was 60 and 105 bpm respectively. The reduction in Bobby's average resting heart rate from baseline across all the verbal prompt suphases was 2.1 bpm. Total calorie expenditure ranged form 0 to 537 (M = 149.3) during the verbal prompt condition.

Results for Linda

Baseline and Verbal Prompt Conditions Results

The results for Linda are presented in Figures 4-13 through 4-16. Phase changes for Linda are summarized in Table 4-4. Figure 4-13 shows the duration of exercise across all phases for each consecutive session. Linda exercised for 0% of the sessions during baseline and the verbal prompt condition. Linda's average resting heart rate during baseline was 71.6 beats per minute (bpm) and 75.11 bpm for each of those conditions respectively. Figure 4-15 shows resting and exercise pulse rate or beats per minute.

Duration Probe

To decide upon a duration criterion with which to initiate differential duration reinforcement subphases, we conducted a duration probe. The probe consisted of asking Linda to ride the stationary bicycle for as long as she could. She was further instructed that she could stop at any time of her choosing without penalty and that 100 calories would be added to her calorie sheet for her cooperation. During the probe session, Linda rode the stationary bicycle for 3.5 minutes. Figure 4-13 presents exercise duration data across all sessions. Her resting pulse was 71 bpm and her exercise pulse was 110 bpm (see Figure 4-15). The data show that she emitted 59 responses per minute (see Figure 4-14) and expended a total of 46 kcal. (see Figure 4-16). The total exercise duration during the duration probe was the starting duration criterion for the next set of subphases constituting the differential reinforcement duration criterion.

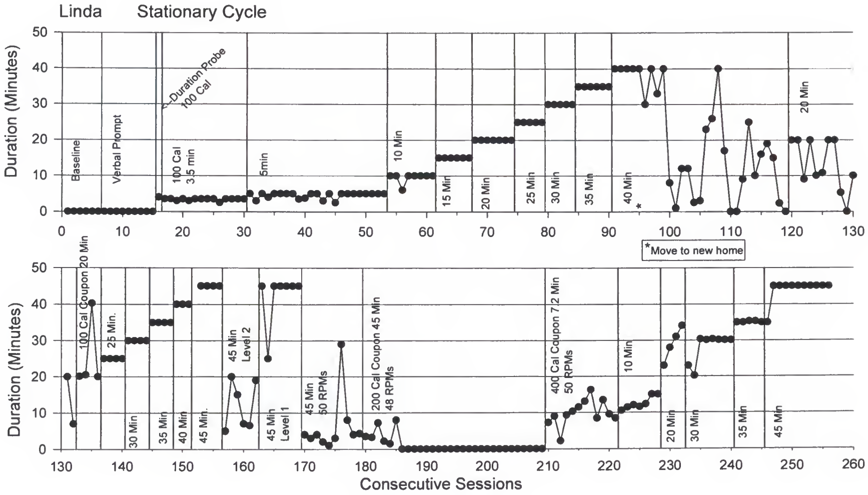

Figure 4-13. Exercise duration across conditions for Linda.

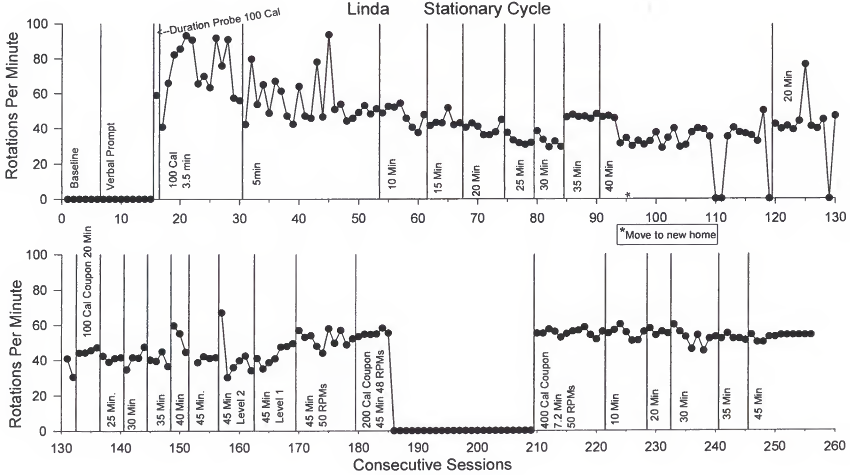

Figure 4-14. Rotations per minute across phases for Linda.

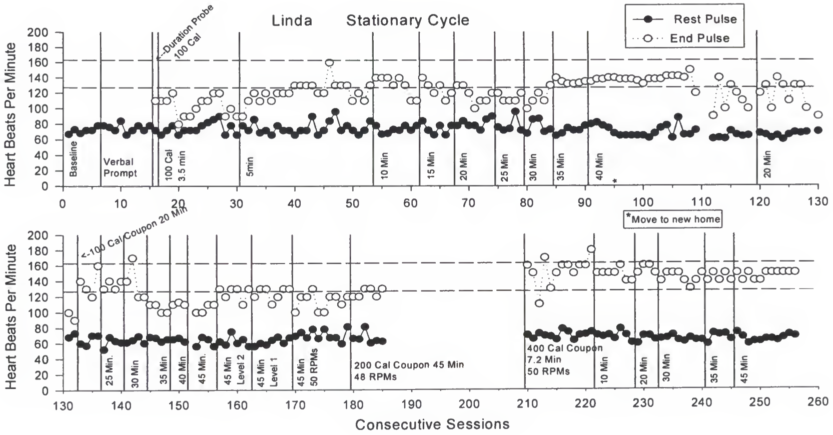

Figure 4-15. Heart beats per minute across phases for Linda. Filled circles show resting pulse rate and open circles show exercise pulse rate. Dashed horizontal lines show target exercise heart rate zone.

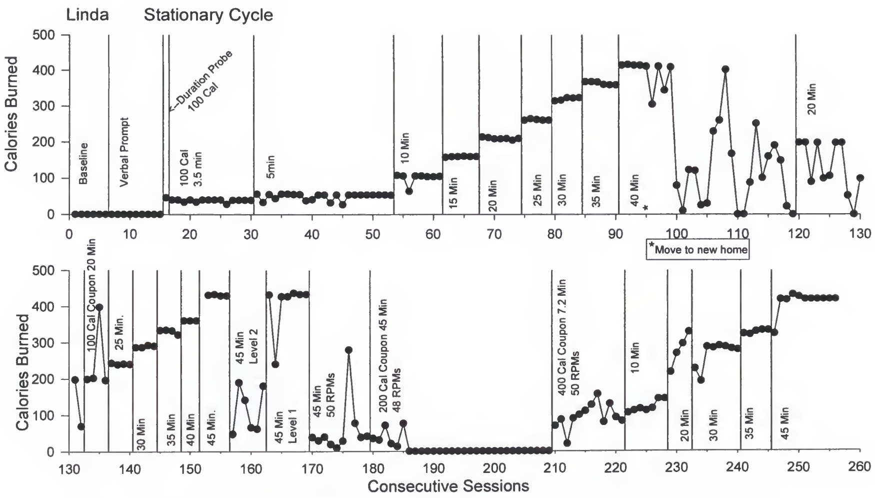

Figure 4-16. Total calories burned across phases for Linda.

Table 4- 4. Phase change summaries for Linda

Phase change
Baseline
Verbal prompt only
Duration probe for 100 kcal.
Earn 100 kcal., 3.5 min. duration criteria, level 1
Earn 100 kcal., 5 min. duration criteria, level 1
Earn 100 kcal., 10 min. duration criteria, level 1
Earn 100 kcal., 15 min. duration criteria, level 1
Earn 100 kcal., 20 min. duration criteria, level 1
Earn 100 kcal., 25 min. duration criteria, level 1
Earn 100 kcal., 30 min. duration criteria, level 1
Earn 100 kcal., 35 min. duration criteria, level 1
Earn 100 kcal., 40 min. duration criteria, level 1
Earn 100 kcal., reduce duration criteria to 20min., level 1
Earn 100 kcal. COUPON, 20 min. duration criteria, level 1
Earn 100 kcal. COUPON, 25 min. duration criteria, level 1
Earn 100 kcal. COUPON, 30 min. duration criteria, level 1
Earn 100 kcal. COUPON, 35 min. duration criteria, level 1
Earn 100 kcal. COUPON, 40 min. duration criteria, level 1
*Earn 100 kcal. COUPON, 45 min. duration criteria, level 1
*Earn 100 kcal. COUPON, 45 min. duration criteria, level 2
*Earn 100 kcal. COUPON, 45 min. duration criteria, return to level 1
*Earn 100 kcal. COUPON, 45 min. duration criteria, level 1, *no less than 50 RPMs
*Earn 200 kcal. COUPON, 45 min. duration criteria, level 1, *no less than 48-49 RPMs
7.20 min. duration criterion, 50 RPMs, *Earn 400 kcal. Coupon
10 min. duration criterion, 50 RPMs, *Earn 400 kcal. Coupon
20 min. duration criterion, 50 RPMs, *Earn 400 kcal. Coupon
30 min. duration criterion, 50 RPMs, *Earn 400 kcal. Coupon
35 min. duration criterion, 50 RPMs, *Earn 400 kcal. Coupon
45 min. duration criterion, 50 RPMs, *Earn 400 kcal. Coupon

Differential Reinforcement (100kcal.) of Duration

The next 10 subphases were designed to systematically increase the time Linda spent continuously riding the stationary bicycle at the easiest setting level one. Across these subphases, the responses she emitted per minute ranged from 0 to 94 (M= 46.6). Figure 4-15 shows that her average exercise heart rate and resting heart rates were 122 and 71.7 bpm, respectively. Her resting heart rate decreased by 3.41 bpm from the verbal prompt condition to the differential reinforcement condition.

The data show that duration of exercise (see Figure 4-13) and responses per minute (see Figure 4-14) became highly variable during the ninth differential reinforcement of duration subphase (e.g., 40-minute duration at level one earn 100 kcal.). The criteria for earning 100 kcal. for this subphase was riding the bicycle continuously for 40 minutes at the lowest equipment setting of one. Given the variability of the data, we reduced Linda's duration criterion to 20 minutes, the median duration value of the previous subphase. This reduced duration subphase initiated another subphase sequence designed to approximate the 45-minute duration goal beginning with giving her a "calorie coupon" contingent upon meeting the exercise session criterion.

Differential Reinforcement (Calorie Coupon) of Duration

After reducing her duration requirement for reinforcement to 20 minutes, we initiated another phase change in which Linda was given a brightly colored calorie coupon designed especially for her. During this study, Linda was moved to a new group home where exercise equipment was not available. As a result, she had to be transported by ARC staff to another group home to exercise while her calorie sheet was frequently left behind at Linda's residence. This precluded accurate execution of the reinforcement procedure of adding the number of calories earned for exercising to the total on the sheet. Thus, she was immediately given a calorie coupon contingent upon completion of exercise and meeting her session criteria. Upon return to her residence, she presented this coupon to the group home staff. The caloric face value of the coupon was added to the available calorie total on her calorie sheet. The coupon was stapled in the upper right hand corner of the calorie sheet. Verification and accuracy of this part of the procedure was achieved by follow-up phone calls each day and calorie sheet checks by the primary investigator, Linda's primary research assistant, and the behavior specialist employed by the ARC.

The face value of the coupon remained at 100 kcal. until Linda was riding the stationary bicycle continuously for 45 minutes at level one. Her average resting heart rate across these subphases was 63 bpm and her average exercise heart rate was 122.2 bpm (Figure 4-15). Figure 4-14 shows that Linda's average response rate was 43.2 (range 0-67) and she expended an average of 195 kcal. (range 0-437kcal.).

Although Linda had met the 45-minute exercise duration goal, her exercise heart rate was not in her training sensitive zone (THR). We decided to raise the equipment setting to level two at which point her exercise duration dropped to the average of 10.4 minutes (range 0-20 min) from the previous phase during which she was exercising for 45 minutes (see Figure 4-13). Figure 4-15 shows that the average number of responses Linda emitted per minute dropped form 40.8 in the previous subphase to 35.5. We initiated a return to the previous subphase (e.g., earn 100 kcal. coupon for exercising continuously for 45-minutes at level one). The 45-minute duration was recovered and her response rate rose to an average of 42.9 rpms.

At this point we decided to impose a different intensity/rate requirement of 50 responses per minute (rpm) in an attempt to get Linda's heart rate within her training sensitive zone. Another deterioration in performance resulted. Linda's average exercise duration dropped to just over 5 minutes. This decrease precipitated our decision to decrease the imposed rpm requirement to 48-49 based on our previous observations that at this rate performance was maintained. We also increased the caloric face value of the coupon to 200 kcal. while the duration requirement reminded at 45 minutes. In other words, Linda could now earn 200 kcal. for riding the bicycle for 45 minutes and emitting at least 48 to 49 responses per minute. Figure 4-13 shows that her duration increased and ranged from only 1.4 to 8 minutes (Median = 7.2 minutes).

The median duration of the previous subphase was 7.2 minutes. The duration criterion for the next series of subphases was initiated at that median value of 7.2 minutes. The rate criterion was changed to the previous criterion of 50 rpms. and the amount of calories she could earn was increased from 200 to 400. The face value of the calorie coupons was changed accordingly. The duration criterion was systematically increased across the next five subphases while the amount of calories Linda could earn and her rate requirement remained constant. Across this set of subphases, Linda met the 45-minute duration requirement emitting an average of 54 rpms ranging from 45-60 rpms (Figure 4-14). Linda's average resting heart rate was 66.9 bpm and her average exercise heart rate was 149 (Figure 4-15). Figure 4-16 shows that she was expending an average of 242.7 kcal. per session (range 20-433).

Results for Mary

Baseline

The results for Mary are presented in Figures 4-17 through 4-20. Phase changes for Mary are summarized in Table 4-5. Figure 4-17 shows the duration of exercise across all phases for each consecutive session. Mary exercised for 0% of the sessions during baseline. Mary's average resting heart rate during baseline was 79.5 beats per minute (bpm). Figure 4-19 shows resting and exercise pulse rate or beats per minute.

Verbal Prompt Condition

Figure 4-17 shows session duration across all conditions. During the verbal prompt condition, Mary rode the stationary bicycle at the lowest setting level one for an average of 10. 5 minutes (range 0 to 25 min.). Her resting and exercise heart rates were

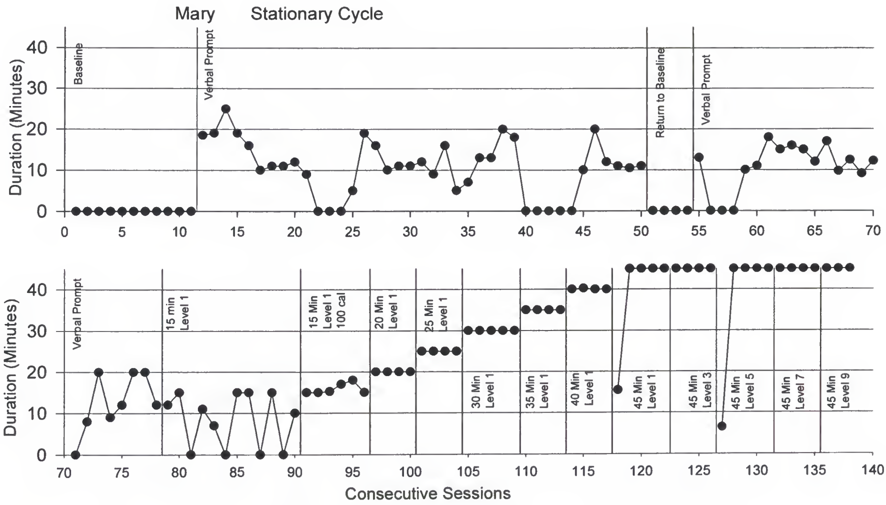

Figure 4-17. Exercise duration across conditions for Mary.

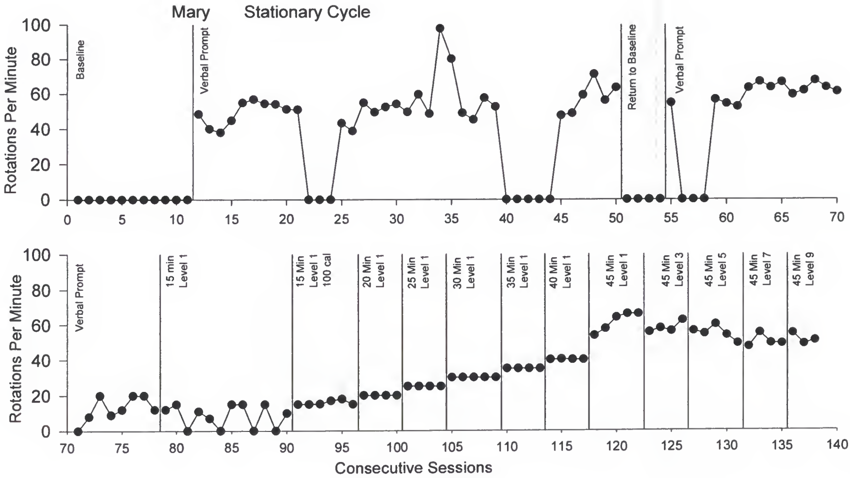

Figure 4-18. Rotations per minute across phases for Mary.

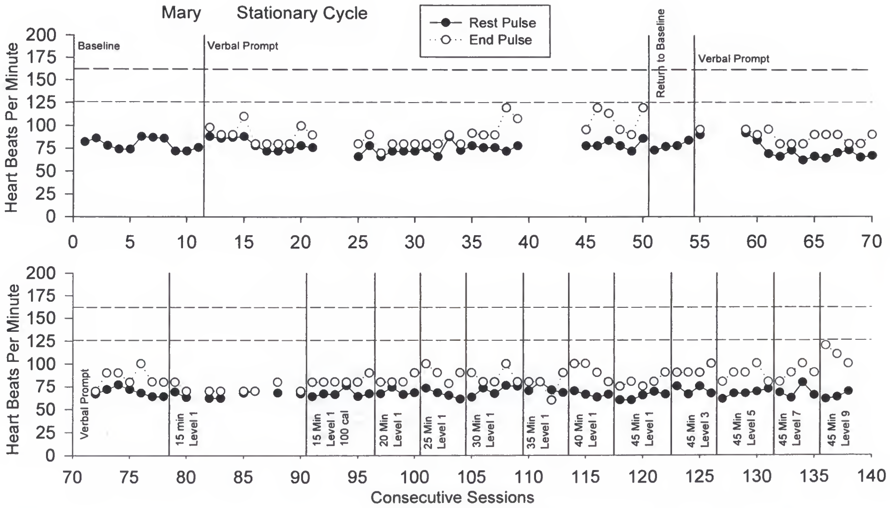

Figure 4-19. Heart beats per minute across phases for Mary. Filled circles show resting pulse rate and open circles show exercise pulse rate. Dashed horizontal lines show the target exercise heart rate zone.

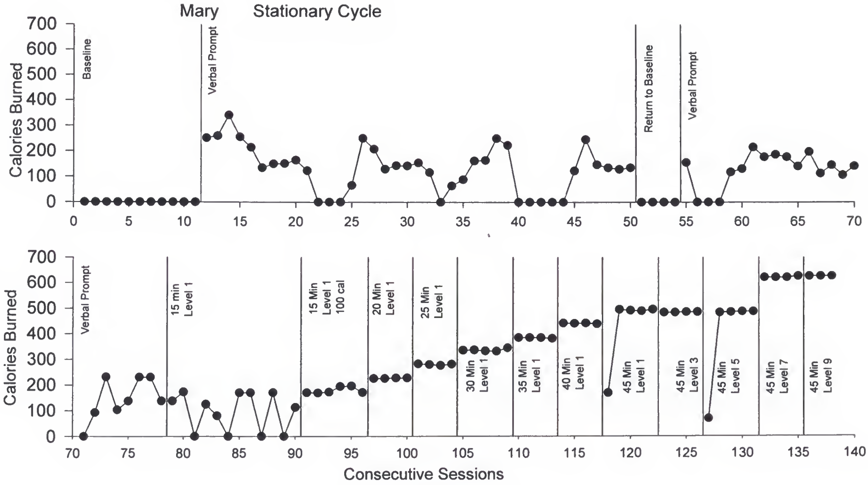

Figure 4-20. Total calories burned across phases for Mary.

Table 4- 5. Phase change summaries for Mary

Phase change
Baseline
Verbal prompt
Return to baseline
Return to verbal prompt (no criteria)
Verbal prompt 15 min., level 1
Earn 100 kcal., verbal prompt 15 min., level 1
Earn 100 kcal., verbal prompt 20 min., level 1
Earn 100 kcal., verbal prompt 25 min., level 1
Earn 100 kcal., verbal prompt 30 min., level 1
Earn 100 kcal., verbal prompt 35 min., level 1
Earn 100 kcal., verbal prompt 40 min., level 1
Earn 100 kcal., verbal prompt 45 min., level 1
Earn 100 kcal., verbal prompt 45 min., level 3
Earn 100 kcal., verbal prompt 45 min., level 5
Earn 100 kcal., verbal prompt 45 min., level 7
Earn 100 kcal., verbal prompt 45 min., level 9
Moved to NYC

76 and 91.7 bpm. respectively (see Figure 4-19). Figure 4-18 presents Mary's response rate data across all conditions. It shows that Mary emitted 0 to 98 rpms (M= 43.2). Figure 4-20 shows the total caloric expenditure across all sessions. The data show that Mary expended an average of 114.4 (range 0–342) calories per session across the verbal prompt condition. Mary's pattern of responding was variable during this condition. She was having a whole host of problems during this time including treatment for depression, third degree sunburn, and court proceedings regarding adjudication. We decided to implement a return to baseline condition.

Return to Baseline

Mary exercised for 0% of the sessions across the return to baseline condition. Her average resting heart rate was 77. This condition was followed by a return to verbal prompt condition. The condition was repeated to provide duration data that we could use to establish duration criterion for subsequent duration reinforcement subphases.

Return to Verbal Prompt Condition

Figure 4-18 shows that her resting heart rate averaged 71.3 bpm. and her exercise heart rate averaged 86.4 bpm. across sessions. Mary's response rate ranged from 0 to 68 rpms. (M= 52.4) as shown in Figure 4-18. Average total calorie expenditure was 81.9 ranging from 0 to 232 calories across sessions (see Figure 4-20). Her median exercise duration was 12 minutes (M= 11.3 min.) as shown in Figure 4-17, however, we decided to set her duration criterion for the next subphase above the median value of the previous condition at 15 minutes. This team decision was based on the range of time she spent exercising during the first verbal prompt condition (0 to 25 min.) and the second verbal prompt condition (0 to 20 min.). The data show (see Figure 4-17) Mary was able to ride the stationary bicycle for 15 minutes.

Differential Reinforcement (100 kcal.) Duration Condition

The next series of phase changes began with the addition of calories contingent upon exercising continuously for 15 minutes. The duration for reinforcement was systematically raised across subsequent subphases until Mary was riding the bicycle for 45 minutes. Mary's average resting heart rate was 68.2 bpm. and her average exercise heart rate was 84.2 bpm. (Figure 4-18). She was exercising for an average of 42.2 minutes across all seven subphases within this condition reaching the 45-minute duration criterion in the last as shown in Figure 4-17. Responses per minute ranged from 0 to 71.7 rpms. (M = 58.6). Total calorie expenditure ranged from 0 to 496 kcal. burned across all sessions (M = 227.8). Figures 4-18 and 4-20 present Mary's rate and calorie expenditure data across all sessions.

Differential Reinforcement (100kcal.) Intensity Condition

The final four subphases were designed to increase Mary's exercise heart rate. Raising the equipment setting from level one to levels three, five, seven, and finally nine systematically increased her intensity requirements. The 45-minute duration requirement and reinforcers remained the same at 100 calories. Her resting heart rate averaged 67.4 bpm. which was a decrease of 12.1 bpm. from baseline and a .8 bpm. reduction from the previous differential reinforcement duration condition. Response rate ranged from 46.7 to 62.2 rpms (M= 53.6) with average total caloric expenditure 340. 7 (range 0-626) across sessions during this condition. Mary's data are presented in Figures 4-17 through 4-20. At this point, Mary moved to another state.

Results for Cathy

Baseline

The results for Cathy are presented in Figures 4-21 through 4-24. Phase changes for Cathy are summarized in Table 4-6. Figure 4-21 shows the duration of exercise across all phases for each consecutive session. Cathy exercised for 0% of the sessions during baseline. Cathy's average resting heart rate during baseline was 69.5 beats per minute (bpm). Figure 4-23 shows resting and exercise pulse rate or beats per minute.

Verbal Prompt Condition

Figure 4-21 shows Cathy's exercise duration per session across as conditions. She rode the stationary bicycle at the lowest setting equipment setting (level 1) for the median duration of six minutes. Therefore, six minutes was the duration verbal prompt for the next subsequent subphase. This was followed by verbal prompt for ten minutes and then a return to baseline in the next subphase series.

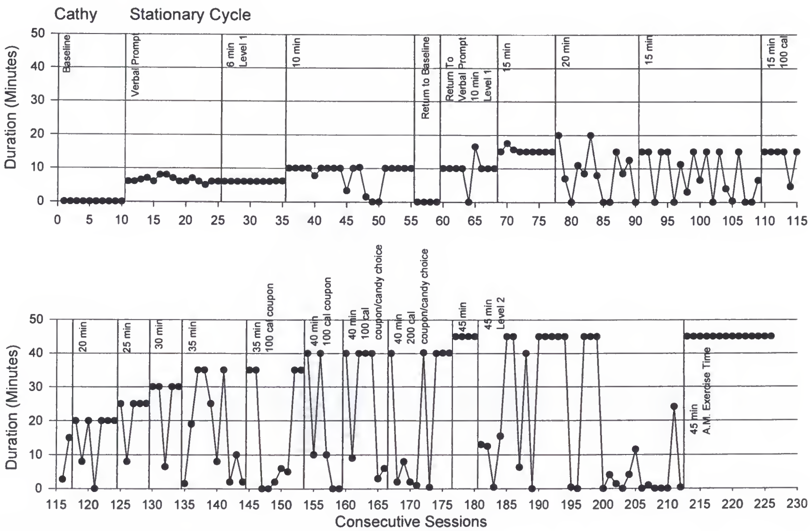

Figure 4-21. Exercise duration across conditions for Cathy.

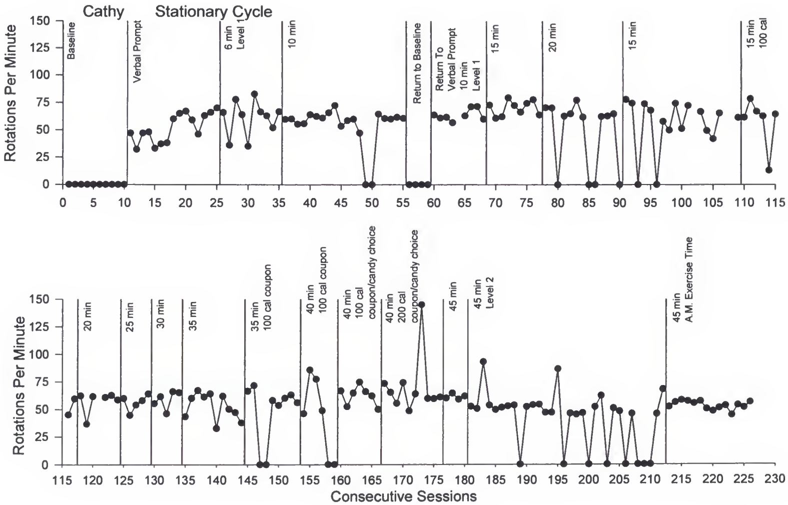

Figure 4-22. Rotations per minute across phases for Cathy.

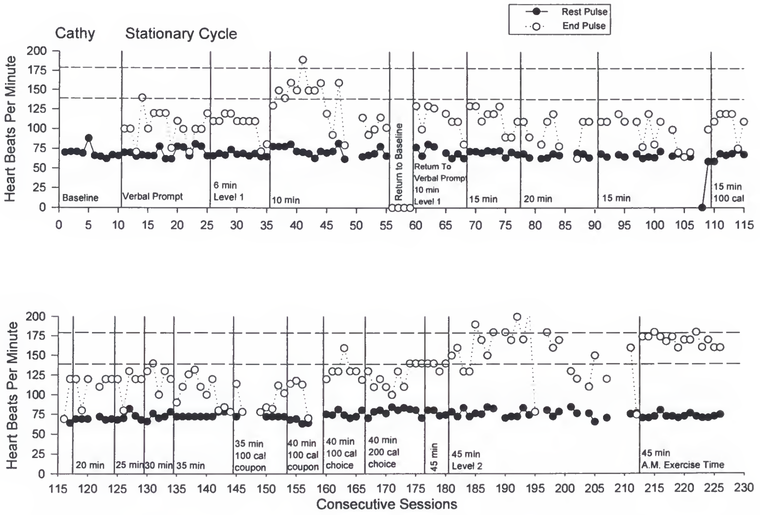

Figure 4-23. Heart beats per minute across phases for Cathy. Filled circles show resting pulse rate and open circles show exercise pulse rate. Dashed horizontal lines show target exercise heart rate zone.

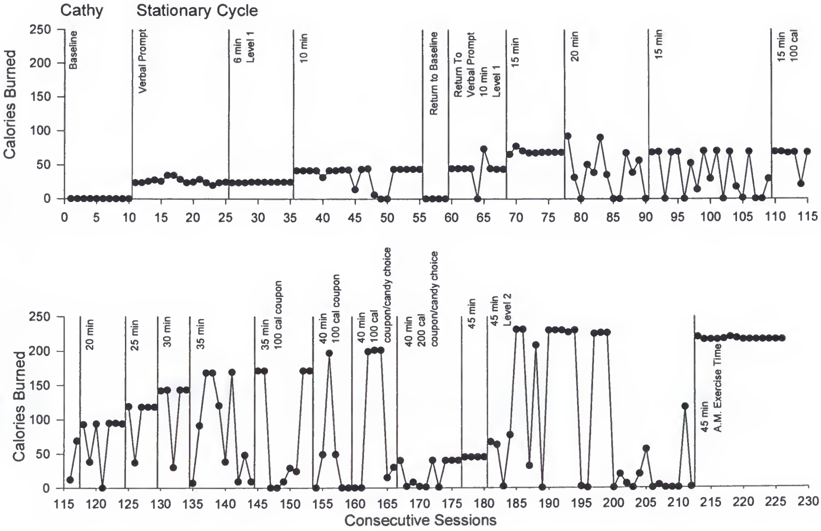

Figure 4-24. Total calories burned across phases for Cathy.

Table 4-6. Phase change summaries for Cathy

Phase change
Baseline
Verbal prompt only
Verbal prompt 6 min., level 1
Verbal prompt 10 min., level 1
Return to baseline
Return to verbal prompt 10 min., level 1
Verbal prompt 15 min., level 1
Verbal prompt 20. min., level 1
Return to verbal prompt 15 min., level 1
Earn 100 kcal., 15 min., level 1
Earn 100 kcal., 20 min., level 1
Earn 100 kcal., 25 min., level 1
Earn 100 kcal., 30 min., level 1
Earn 100 kcal., 35 min., level 1
Earn 100 kcal-COUPON., 35 min., level 1
Earn 100 kcal-COUPON., 40 min., level 1
Earn 100 kcal-COUPON/CANDY CHOICE., 40 min., level 1
Earn 200 kcal-COUPON/CANDY CHOICE., 40 min., level 1
Earn 200 kcal-COUPON/CANDY CHOICE., 45 min., level 1
Earn 200 kcal-COUPON/CANDY CHOICE., 45 min., level 2

The decision to return baseline was based on several variables. Cathy had taken a new night job working for the Department of Transportation (D.O.T.). As a result, she slept most of the day. Her verbal behavior throughout the exercise sessions was perseverative. She continuously complained about being tired and not wanting to exercise. Behavior problems (e.g., aggression, urinating on the floor, screaming fits) were a frequent occurrence and she was placed on medication (Prozac) for depression during this time. The dosage of Prozac was later increased from 40 mg. to 60 mg. and then reduced again to 40 mg. across a time frame of three weeks. Then the group home staff asked us to switch her running time, first to the early morning after she returned from work and then to the evening before she went to work. This flux presented a logistics problem for the research team and precipitated the return to baseline so that we could develop a new strategy. Fortunately, the problems resolved themselves because Cathy quit the D.O.T. and went back to work at the ARC's sheltered workshop. The verbal prompt ten-minute duration, equipment setting level one was reinstated with her session conducted at the usual time.

The verbal prompt duration was increased from 10 to 15 minutes and then 20 minutes before a return to the verbal prompt duration of 15 minutes. This return to the latter was due to the fact that she only met her 20-minute duration criterion two sessions during the previous subphase and refused to exercise on the last session of that subphase. Her average resting and exercise heart rates across the subphases during the verbal duration prompt condition were 68.4 (a reduction of 1.1 bpm from baseline) and 104.9 bpm. respectively (Figure 4-23). Cathy's exercise duration data per session across all conditions are presented in Figure 4- 21. The data show that she rode the bicycle for an average of 8.14 minutes. Her total calorie expenditure per session ranged from 0 to 93 kcal. (M = 27.7 kcal.). These data are presented in Figure 4-24. Figure 4-22 shows responses per minute per session across all conditions. This figure shows that Cathy emitted a range of 0 to 83 rpms (M = 55.7).

Differential Reinforcement (100kcal.) Duration Condition

During the last subphase of the verbal duration prompt condition (verbal prompt to exercise for 15 minutes at level one), Cathy did not meet the duration criterion 11 out of 19 days (M = 7 min.). At this point, Cathy was given the opportunity to earn 100 calories for exercising continuously for 15 minutes. Over the next four subphases, her duration criteria were systematically increased to 35 minutes while the magnitude of the reinforcer (100 kcal.) and equipment level (level one) remained constant. The data show that during this sequence of subphases, Cathy's average resting and exercise heart rates per session were 71.1 (an increase of 2.7 bpm from the previous condition) and 109 .9 bpm (see Figure 4-23). Cathy rode the bicycle for an average duration 17.5 minutes (Figure 4-21) emitting an average of 55.7 rpms (range 0 to 66.9 rpms.). Total calorie expenditure for each session across these subphases ranged from 0 to 168 (M = 60.3 kcal.). Figures 4-22 and 4-24 show response rate and total calories expenditure per session across all conditions.

Differential Reinforcement (Coupon 100kcal.) Duration Condition

Given that Cathy met the duration criterion of 35 minutes on only 3 out of 10 days during the previous subphase, we changed the reinforcement procedure to coupon presentation contingent upon meeting her session criteria. The coupon presentation protocol was identical to that used with Linda. Over two subphases, her duration criterion was increased from 35 to 40 minutes. During the latter subphase, she met the duration criterion (40 min.) only 2 out of 6 days. Cathy's average resting heart rate was 70. 9 bpm (a reduction of .2 bpm from the preceding condition) and her average exercise heart rate was 96.8. She rode the bicycle for an average of 16.7 min. and her response rate ranged from 0 to 85.6 (M = 45.7 rpms.). Total calories expenditure ranged from 0 to 201 kcal. (M = 61.2 kcal.). Thus, the next set of subphases was designed to increase both duration of exercise and exercise heart rate.

Differential Reinforcement Duration and Intensity Condition: Choice Manipulation

After brainstorming with the ARC staff, the research team decided to give Cathy a choice of either a coupon with a face value of 100 kcal. or candy (100 kcal.) contingent upon exercising for 40 minutes at level one. We asked Cathy to identify a highly preferred food item. She identified a particular chocolate candy that was kept in stock at the group home for use as reinforcers. The nutritionist already identified the amount and caloric value of this item. Cathy's duration requirement was 40 minutes at level one for the first choice subphase. This criterion was met on only four out of seven opportunities. She choose the candy on 50% of the sessions and the coupon on 50% of the sessions for which she met the duration criterion.

Next, we increased the face value of the calorie coupon from 100 to 200 kcal. The face value of the coupon remained at 200 kcal. until the end of the experiment. The caloric value of the candy was held constant at 100 kcal. Again, when given the opportunity to choose the coupon (face value 200 kcal.) or candy (100 kcal.), her choices were evenly distributed between the two alternatives. When the duration criterion was increased to 45 minutes, she chose the 200 kcal. coupon 100% of sessions in which she met the criterion.

The final set of subphases were designed to get Cathy exercising consistently for 45 minutes with her exercise heart rate in her THR training sensitive zone. This was accomplished by raising the equipment setting to level two and ultimately changing her exercise time to the morning. The latter change was based on distractions posed by other residents in close proximity that were believed to interfere with Cathy's exercise behavior. The duration requirement (45 min.) and reinforcer choice options were held constant (100-kcal. candy or calorie coupon face value 200 kcal.). At the end of the experiment, Cathy was exercising continuously for 45 minutes at level two for 14 consecutive days, 85% of which she chose the coupon face value 200 kcal.

Across the choice manipulations, her average resting heart rate was 75. 4 bpm. an increase of 4.5 bpm. from the set of subphases during which the coupon was introduced. Her average exercise heart rate was 147.7 bpm. (Figure 4-23). Response rate data per session across conditions are shown in Figure 4-22. These data show that she was emitting an average of 51.3 rpms (range 0 to 145 rpms). Total caloric expenditure per session ranged from 0 to 231 kcal. (M = 89.1 kcal.). Total caloric expenditure per session across conditions is presented in Figure 4-24.

Results for William

Baseline

The results for William are presented in Figures 4-25 through 4-28. Phase changes for William are summarized in Table 4-7. Figure 4-25 shows the duration of exercise across all phases for each consecutive session. William exercised for 0% of the sessions during baseline. Williams' average resting heart rate during baseline was 74.4 beats per minute (bpm). Figure 4-27 shows resting and exercise pulse rate or beats per minute.

Verbal Prompt Condition

Figure 4-25 shows the duration data per session across conditions for William. During the verbal prompt only condition, William rode the stationary bicycle set at the lowest intensity setting of level one for an average of 1.5 minutes (median 1.3 min.). Figure 4-27 presents William's heart rate data per session across conditions. This figure shows that his average resting heart rate was 72.9 bpm. (a reduction of 1.5 bpm from baseline) and his average exercise heart rate was 127.8 bpm. William's range of responses per minute was 0 to 63.1 rpms (M = 24.5 rpms). Total caloric expenditure ranged from 0 to 64 kcal. (M = 16.1 kcal.). Figures 4-26 and 4-28 present response rate and total caloric expenditure per session across conditions. Based on these data, we decided to differentially reinforce riding the bicycle for inceasingly longer periods of time beginning with two minutes.

Differential Reinforcement (100 kcal.) Duration Condition

The exercise duration criterion for reinforcement was increased across four subphases. Beginning with requiring William to ride the bicycle continuously for two minutes, he eventually was exercising for 15 minutes. At this point in the study, his participation was discontinued due to a move out of state. The data show that his average

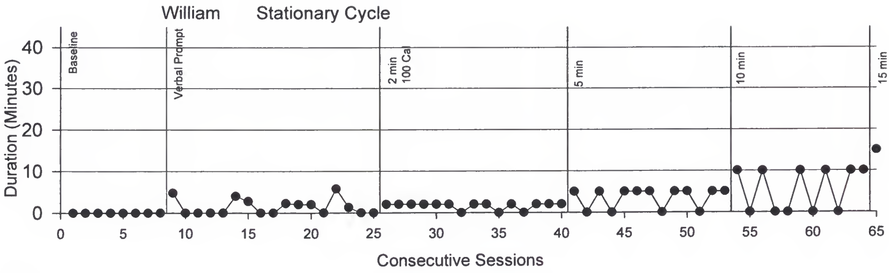

Figure 4-25. Exercise duration across conditions for William.

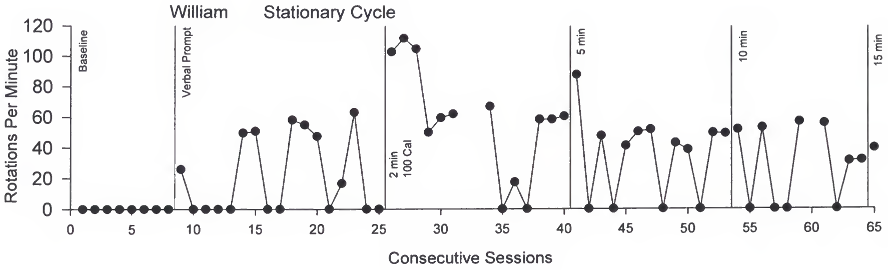

Figure 4-26. Rotations per minute across phases for William.

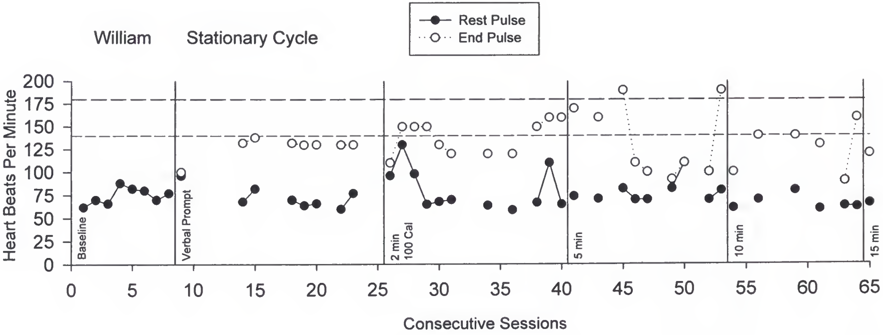

Figure 4-27. Heart beats per minute across phases for William. Filled circles show resting pulse rate and open circles show exercise pulse rate. Dashed horizontal lines show target exercise heart rate zone.

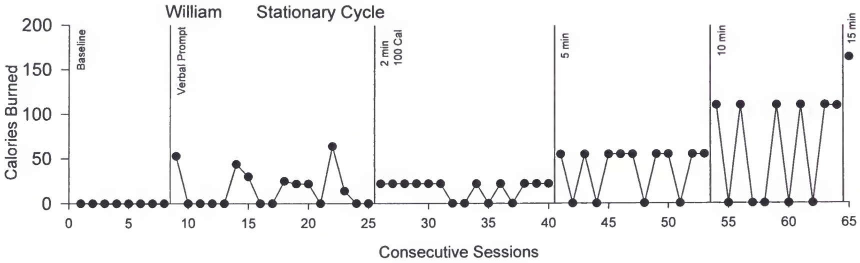

Figure 4-28. Total calories burned across phases for William.

Table 4-7. Phase change summaries for William

Phase change
Baseline
Verbal prompt
2 minutes earn 100 kcal
5 minutes earn 100 kcal
10 minutes earn 100 kcal
15 minutes earn 100 kcal
Moved to another state

resting heart rate was 76.4 bpm (an increase of 3.5 bpm from the previous condition) and his average exercise heart rate was 134.1 bpm (Figure 4-27). William continuously rode the bicycle for an average of 3.5 minutes (median 2 min) as shown in Figure 4-25. He emitted an average of 41.4 rpms (range 0 to 112 rpms) and expended an average of 33.9 total calories per session (range 0 to 164 kcal). Figures 4-26 and 4-28 show responses per minute and total caloric expenditure per session across conditions.

Results Rockport Walk-A-Mile Fitness Test For All Participants

The results of the Rockport Walk-A-Mile Fitness Test are presented in Tables 4-8 and 4-9. They show that of the two participants who able to walk the one-mile distance initially, Bobby did so in less time after participation in this investigation. Three individuals who were initially unable to walk the entire distance were able to do so after completing this study. Two participants moved out of state before they had to opportunity to walk a mile upon termination of participation. One of these individuals had initially refused to take the test before participation is this study. Another participant refused to attempt to walk a mile before and after participation in this study despite having succeeded in meeting both the duration and exercise heart rate requirements.

Table 4-8. Rockport Walk-A-Mile Fitness Test results before participation

Participant's name	Resting heart rate	Exercise heart rate	Distance	Time
Clara	162 bpm	190 bpm	32 ft.	57 sec.
Rita	90 bpm	180 bpm	667 ft.	27 min.
Bobby	60 bpm	120 bpm	1 mile	53 min.
Linda	Refused	--	--	--
Mary	98 bpm	120 bpm	1 mile	72 min.
Cathy	78 bpm	160 bpm	690 ft.	27 min.
William	Refused	--	--	--

Table 4-9. Rockport Walk-A-Mile Fitness Test results after participation

Participant's name	Resting heart rate	Exercise heart rate	Distance	Time
Clara	79 bpm	160 bpm	1 mile	44 min.
Rita	60 bpm	150 bpm	1 mile	47 min.
Bobby	54 bpm	160 bpm	1 mile	38 min.
Linda	Refused	--	--	--
Mary	Moved			
Cathy	76 bpm	174 bpm	1 mile	56 min.
William	Moved	--	--	--

Results of the Pre- and Postexercise Program Questionnaire

Six of the seven participants were administered the pre- and postexperiment questionnaire before and after participation in the present study. An abrupt and unexpected move precluded postparticipation administration for only one participant. A researcher read the statements to the individual participants. The participants were then asked if they agreed or disagreed with the statement. The researcher circled "yes" if the response was agree or "no" if the response was disagree.

In general, participants' verbally reported attitudes and beliefs regarding exercise changed from pre-to-post study participation. Statements were grouped according to two themes. The first theme was personal attitudes towards exercise (e.g., I like to exercise, exercising is fun, I exercise as often as I can). The second theme was beliefs related to the beneficial effects of exercise (e.g., exercise is good for me, exercising helps me to loose weight, it is important for me to exercise). Results are discussed in terms of direction of change, negative-to-positive or positive-to-negative, across administrations.

The responses of Cathy to the exercise attitudes statements changed 100% in the positive direction after participation. Fifty percent of her responses on the beliefs regarding the beneficial effects of exercise statements changed in the positive direction as well. William's responses were scored as negative across the board preparticipation. Postparticipation data are not available for him because of a sudden and unanticipated move to another state. Thirty-three percent of the responses given by Mary and Linda on the statements in the attitude theme category changed in the positive direction. For the beliefs category, only Linda's responses changed from negative to positive (50% of questions pre-to-postparticipation administration). Mary's responses to the beliefs statements were positive initially. For Clara, 100% of her responses on the attitudes statements changed in the positive direction across administrations. Her beliefs regarding the beneficial effects of exercise changed by only 16.7% because they were largely positive preparticipation. The same is true for Bobby with his reported beliefs changing only 33%; however, 77.8% of his responses to the attitudes statements changed from negative to positive after participation. Finally, Rita's responses to the attitudes statements changed (22%) with her responses to the beneficial effects of exercise theme statements remaining positive across administrations.

Results of the Exercise Program Satisfaction Sheet

The responses of 10 ARC staff persons were gathered at the end of this study. These individuals were the group home staff persons who were trained to implement the procedures reported here. They were also the personnel who staffed the shift on duty at the time experimental exercise sessions were conducted by the researchers.

A statement was read to the staff person by a researcher. They were then asked to choose a number on a scale of 1 to 5 that corresponded to their response. A rating of 1 corresponded to strongly agree and a rating of 5 corresponded to strongly disagree. Staff ratings on the exercise program satisfaction sheet indicated that 100% of those surveyed rated the program as a success. Likewise, 100% also reported that participants improved physically, calories were effective as reinforcers, and the likelihood of participants exercising in the absence of study participation was negligible. Staff indicated that their ratings were either a 2 or a 1 (strongly agree) on the Likert scale for those statements.

Ninety percent of those surveyed either strongly agreed (a rating of one) or rated the statement pertaining to the ease of monitoring a participant's exercise behavior a 2 on the Likert scale. Similarly, 90% rated the statement pertaining to their willingness to implement the procedures employed in the present study with other people as either a 2 or a 1 (strongly agree).

Seventy-percent gave the same ratings, either a 2 or a 1 (strongly agree), for statements pertaining to the ease of using the procedures employed in the present study with other populations, and the belief that these procedures would work with those populations. Fifty-percent of the staff persons gave a rating of 1 or 2 to the statement indicating that a participants' exercise behavior could easily be counted and timed. No ratings of 5 (strongly disagree) were given, and only three ratings of a 4 were given. The latter was in response to only two statements. The first was the ease with which these methods may be used with others, and the second was the ease with which staff persons could count and time participants' exercise behavior.

CHAPTER 5
DISCUSSION

This study is a behavioral outcome study that demonstrated the feasibility and practicality of establishing consistent compliance with an exercise program when base rates of exercise behavior are zero. None of the seven participants engaged in any exercise behavior during baseline. Compliance with the exercise program and increases in exercise rate and duration were observed for all participants except one when the differential reinforcement procedure was initiated. The individual not exposed to differential reinforcement contingencies exercised consistently in the absence of programmed contingencies. Specific exercise behaviors were examined formally using a single subject changing criterion design in conjunction with operational definitions and procedures in place for tighter control than described in previous interventions (Caldwell et al., 1986; Liquori, 1998; Mulins & Vogl-Maier, 1978; Nardella et al., 1983; Page et al., 1983; Silverthorn & Hornak, 1993). The results of this investigation show that the use of calories and preferred food items can be used to reinforce exercise. This suggests that procedures using similar reinforcement procedures may be beneficial in the treatment of the sequelae of problematic behavior demonstrated by individuals with Prader-Willi syndrome.

Traditionally, the most widely accepted treatment protocols are those that "rely on strict control of access to food and on using nonfood rewards as positive reinforcers for desired behavior" (Gibbons & O'Donoghue, 1998, p. 34). Our findings support those reported by Caldwell et al. (1986) who found that exercise could be reinforced with portions of preferred food items. Not only was the use of calories as reinforcers employed in the present study but also the immediate provision of food items contingent upon completion of prescribed exercise. Of the participants who competed this study, all but one was expending more average total calories than he/she earned; however, the range of total caloric expenditure for *all* participants far exceeded those provided contingently. Table 5-1 presents the average and range of total calories expended by each participant across all experimental conditions.

Table 5-1. Average and range of caloric expenditure

Name	Mean total caloric expenditure during exercise	Range of caloric expenditure
Clara	249.7	0 to 460
Bobby	149.3	0 to 537
Linda	242.7	0 to 437
Rita	138.5	0 to 433
Mary	340.7	0 to 626
Cathy	89.1	0 to 231
William	33.9	0 to 164

The provision of calories and preferred food items contingent upon exercise is one of the features of the procedures described herein that may have contributed to the effectiveness of the exercise program. These reinforcement procedures capitalize on a potentially powerful preexisting reinforcer in the development of adaptive responses. These adaptive responses can aid in the reduction of the morbidity of Prader-Willi syndrome. This fact alone should dispel concerns regarding their use when working with this particular population. There is no doubt that such procedures should be implemented with the utmost care and caution to insure the integrity of the procedure and therefore assure participant safety. This study demonstrates that such an effective program can be designed and implemented without unchecked calorie or food consumption running rampant.

Furthermore, the reinforcement procedures did not impede participant exercise progress nor did calorie or food-related perseveration occur, with respect to the exercise study program. Prader-Willi syndrome lore holds that one of the reasons these reinforcers should not be used is due to the preoccupation with food demonstrated by individuals with PWS. This preoccupation is believed to interfere with behavior (Joseph, Overmier, & Thompson, 1997). The results of this study negate such assumptions.

Another assumption negated by the results of this study relates to impulsivity. “Many individuals with learning and behavior difficulties tend to exhibit behavior that favors immediate rather than longer term consequences” (Neef, Mace, & Shade, 1993, p. 38). This tendency is also believed to be generally applicable to individuals with PWS demonstrating these difficulties. It parlays into discussions of the constructs described as self-control and impulsivity, the polar opposite of self-control. These constructs “have been defined according to choices between concurrently available response alternatives associated with large delayed reinforcers versus small immediate reinforcers” (Neef et al., 1993, p. 38). Individuals with PWS are frequently described as impulsive (Dimitropoulos et al., 2001; Dykens, Cassidy, & King, 1999; Joseph et al., 2002). Although the response choices offered in the present experiment were to exercise or not to exercise, choice of reinforcer for compliance was offered to one participant, Cathy.

When Cathy’s duration requirement was 40 minutes at level one, her choice of reinforcer was candy 50% of the time and a coupon worth 100 kcal. 50% of the time. Her choices between the two reinforcer alternatives remained evenly distributed at the same exercise criteria even when the face value of the coupon was increased to 200kcal. Her reinforcer choice shifted to exclusively selecting the coupon (200kcal.) when the duration requirement was increased to 45 minutes at equipment setting level one. When the intensity requirement was subsequently increased by raising the equipment setting to level 2, while keeping the duration requirement the same, she chose the coupon 85% of opportunities. The remaining 15% of opportunities to choose the reinforcer, Cathy selected the candy.

It appears then her reinforcer choice was indifferent when the duration requirement was lower than 45 minutes (40 min.) with each reinforcer selected 50% of opportunities. Her choice of reinforcer shifted to the larger, delayed reinforcer when the duration and intensity requirements for reinforcement were increased. The expectation that Cathy would indiscriminately choose the immediate preferred food item over the larger, delayed reinforcer, in terms of caloric value, is understandable given anecdotal expectations. This is not what happened. The reinforcer parameters (e.g., quantity, quality, delay) that affect choice behavior with PWS patients need further exploration.

Joseph et al. (2002) found that food quantity influences choice of PWS individuals with delayed larger quantities of food selected over the immediate delivery of smaller quantities. The results of this experiment replicate and extend those of Joseph et al. in that as the work requirements increased, her reinforcer choice shifted to that of the delayed larger reinforcer. In both studies, it was demonstrated that individuals with PWS will, "postpone eating if this choice was associated with larger amounts of food" (p. 134). According to Joseph et al., "In this paradigm, selecting the larger delayed option on a majority of opportunities to do so is said to reflect an ability to delay gratification, or show self-control" (p. 134). Impulsive behavior, and the lack of eating -related self-control by implication, is considered to be a general feature of this disorder

(Dimitropoulos et al., 2001; Dykens, Cassidy, & King, 1999; Joseph et al., 2002). The present study extends the findings of Joseph et al. in that the behavior reinforced was exercise, not selection of computer generated color squares associated with a particular delay to reinforcer. The results of the present investigation in conjunction with that of previous investigations (Joseph et al.) illuminate the need for further empirical research in this area.

The fitness measures used in this study indicate that some degree of health benefit was achieved for most of the participating individuals. All participants completing the study showed heart rate changes in the appropriate direction. Exercise heart rates increased across the various duration and intensity subphases terminating in the THR training sensitive zone. Resting heart rate decreased across experimental conditions. These changes in heart rate are indicative of improved cardiorespiratory health and associated with reduced health risks associated with poor cardiorespiratory fitness and morbid obesity (Anspaugh et al., 1997; Powers & Dodd, 1996). Significant changes in weight also occurred for several participants (see Table 3-1).

Although only four participants completed the post-experiment Rockport fitness test, they were all able to walk continuously the distance of one mile. Prior to the experiment, only Bobby and Mary were able to complete the entire distance. The time in took him to walk one mile was reduced by 15 minutes pre-to-postexperiment participation. Linda refused to take the fitness test both prior to and after her successful participation in the present study. She attributed her post-participation refusal to a foot injury despite medical reports to the contrary. Mary walked the entire mile before the onset of the formal experiment, but a move to another state precluded a postexperiment fitness test. William also moved to another state before completing the experiment and taking the fitness test, but he refused initially to attempt walking a mile before the experiment began.

The participants who completed the one-mile walk postexperiment participation did not do so within any other fitness category but "very poor" fitness range as expressed by the Rockport Company, Inc. (Powers & Dodd, 1996). We implemented this test to provide only a yardstick measure of physical fitness. Despite the fitness classifications set fourth by the Rockport Company, we considered the participants' performance a success. This decision was based on the fact that three individuals who did not initially complete the test did so after the experiment with a fourth person completing the distance in less time than his previous performance.

The exercise program discussed herein is externally valid in that its implementation does not require more staff personnel than are currently available and presently monitoring other aspects of individualized behavioral treatment plans. It shows that the use of events or items already at strength as reinforcers can be successfully incorporated into a program designed to shape and maintain behavior that is not currently at strength in the repertoire of the individual with PWS. These facts are brought to bear on the current exercising status of the individuals who successfully completed this study. They are still exercising with the contingencies we imposed remaining in place. A potential limitation of the present study relates to the continued implementation of programmed contingencies.

According to Nevin (1996),

> The goals of applied behavior analysis include the establishment of desirable, adaptive behavior through interventions that also insure the persistence of that behavior when the intervention ends. Persistence requires that the behavior in question be sufficiently resistant to change so that it continues during the

> transition from treatment contingencies to the natural contingencies of everyday life. (p. 535)

Our primary goal was immediate compliance with an exercise program with concomitant weight loss and increased cardiorespiratory fitness a concern as well. This goal was due to the health risks associated with morbid obesity and related inactivity. When the participants reached their preestablished goals, the continued day-to-day implementation of the experimental exercise program was turned over to ARC staff personnel. The treatment contingencies remain in effect. Future investigations should address the issue of whether natural contingencies associated with weight loss can maintain exercise when the programmed contingencies are removed. There is some evidence to suggest that this may be the case.

Recall Clara, who at the beginning of this study weighed 518 pounds. On several occasions she was nervously waiting for the researchers to arrive so that she could exercise. She stated that she was going to a reunion and wanted to lose more weight by exercising. Clara also asked on one occasion for her duration criterion to be increased beyond what the research team had previously decided. Going on a holiday, she had aspirations of wearing a bathing suit. At another time, she expressed a desire to get down to her goal weight to impress a male peer.

Another participant, Bobby, completed the entire experiment without the provision of programmed caloric reinforcers. Perhaps this was due to the social mediation of his behavior. At any rate, his high rate of compliance and successful completion of the exercise program flies in the face of well-established beliefs regarding PWS patients. They are usually characterized as generally inactive or lethargic (Butler, 1990; Caldwell et al., 1986; Nardella et al., 1983; Thompson et al., 1996; van Mil et al., 2000). That they are stubborn, argumentative, and frequently do not comply with requests are recurrent themes with this population (Dimitropoulos et al., 2001; Dykens & Cassidy, 1996; Dykens et al., 1992; Thompson et al., 1996). When these behavioral characterizations are taken together, it is surprising that Bobby successfully completed the exercise program without the formal provision of calories as reinforcers. Research is needed regarding the efficacy of potential social reinforcers (e.g., attention) and the role of related establishing operations with this population. To date, no such studies have been reported.

The body of research devoted to Prader-Willi syndrome is decidedly small. It is only within the last decade that studies investigating the effects of well-established behavioral interventions have begun to slowly emerge. Areas in need of behavior-based investigations are plentiful (e.g., functional analysis of problem behavior and the type of contingencies involved) and are generally without precedent. Potential areas of inquiry related to this investigation include the effects of different schedules of reinforcement on the exercise behavior of individuals with PWS. Remaining to be determined are the specific schedules of reinforcer presentation that will shape and maintain exercise behavior that is resistant to extinction. Likewise, the most effective parameters of reinforcement beside schedule (e.g., delay, amount, quality) and their effects on exercise behavior are largely unknown with this population. The areas in need of scientific exploration and possibilities are practically endless.

APPENDIX A
PROCEDURAL INTEGRITY DATA COLLECTION FORM

Your name and title: ____

Name of the (RA) research assistant(s) conducting this
session:____
Observed session date: ______________
Name of PWS participant: ____________
Group home number: _______________

Circle your answer

1. Did the RA(s) provide the subject with the appropriate instructions (Ex. During the verbal prompt only condition, RA(s) are only permitted to ask, "Do you want to ride the bike [walk on the treadmill] today?" Yes or No

   If you answered no, what instructions were provided?:

   ____
   ____
   ____

2. Did the RA(s) add additional instructions? Yes or No
   If you answered yes, what were the additional instructions?:

   ____
   ____
   ____

3. Did the RA(s) omit any part of the instructions? Yes or No
   If you answered yes, what part was left out?:

   ____
   ____
   ____

4. Did the RA(s) speak to the participant during the session? Yes or No

5. Did the participant speak to the RA(s) during the session? Yes or No

   If you answered yes, did the RA(s) ignore the participant's vocalizations? Yes or No

6. Did the RA(s) stand away from the participant while he/she was exercising? Yes or No

7. Did the RA(s) provide the appropriate reinforcer at the end of the session? Yes or No

   If you answered no, what event did you observe at the end of the session?:____
   ____
   ____

8. Did the RA(s) take all of the necessary data?
   ☐ Resting pulse: Yes or No
   ☐ Exercise pulse: Yes or No
   ☐ Total steps/rotations: Yes or No
   ☐ Response rate: Yes or No
   ☐ Laps: Yes or No

9. Did the RA(s) check to insure that the exercise equipment was placed on the appropriate setting? Yes or No

10. Did the RA(s) provide the participant with the appropriate S^D to begin the exercise session (e.g., telling the subject to "Please begin.")? Yes or No

    If your answer is no, what S^D did the RA(s) provide (What cue was given to initiate exercise?):
    ____
    ____
    ____

11. Did the RA(s) conduct the session in a professional manner? Yes or No

    If your answer is no, what infractions of professional behavior were observed?:
    ____
    ____
    ____

    Did you point out these infractions to the RA(s)?: Yes or No
    If your answer is yes, were said infractions repeated?: Yes or No

12. Did the RA(s) avoid eye contact with the participant while he/she was exercising?: Yes or No

13. Did the RA(s) conduct the session in a manner that is consistent with the experimental protocol? Yes or No

    If your answer is no, what deviations did you observe?:
    ____
    ____

Did you point out these deviations to the RA(s)?: Yes or No
If your answer is yes, were said deviations repeated?: Yes or No

Additional comments & suggestions:

APPENDIX B
PRE-/POSTEXERCISE PROGRAM QUESTIONNAIRE

Assessment of Attitudes and Beliefs Regarding Exercising

Participant's Identification Code	Date	Researcher's name
______	____________	__________________

Instructions: Please read each statement to the participant. Then ask him or her if they agree or disagree with the statement you just read. Circle the answer that corresponds with his/her answer. If they agree with the statement, circle yes. If they disagree with the statement circle no.

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1. I think that exercise is good for me. Yes or No
2. I like to exercise. Yes or No
3. I think that most people like to exercise Yes or No
4. I exercise every day. Yes or No
5. I exercise as often as I can. Yes or No
6. I look forward to exercising Yes or No
7. Exercising makes me feel good. Yes or No
8. Exercising helps me to loose weight. Yes or No
9. I *do not* like to exercise. Yes or No
10. I *do not* exercise every day. Yes or No
11. I think that most people *do not* like to exercise. Yes or No
12. Exercising *does not* help people to loose weight. Yes or No
13. I *do not* think that exercise is good for me. Yes or No
14. Exercising is fun. Yes or No
15. It is important for me to exercise. Yes or No

APPENDIX C
EXERCISE PROGRAM SATISFACTION SHEET

Name: ________________
Date: ________________
Interviewer: ________________

Instructions: Please read each statement to the participant. When reading, fill in each blank with the participants' name. Then ask him or her to choose a number that corresponds to how they feel about the statement just read. Circle the answer that corresponds with his/her answer on a scale of 1 to 5 with 1 = strongly agree and 5= strongly disagree.

1. I think that this exercise program was successful.
   1 2 3 4 5
   Strongly agree Strongly disagree

2. _______ has shown a lot of physical improvement by participating.
   1 2 3 4 5
   Strongly agree Strongly disagree

3. The methods used in this program are easy for others to use.
   1 2 3 4 5
   Strongly agree Strongly disagree

4. It was easy to monitor ______________'s exercises.
   1 2 3 4 5
   Strongly agree Strongly disagree

5. It was easy to implement the shaping procedures.
   1 2 3 4 5
   Strongly agree Strongly disagree

6. I think that calories are effective reinforcers.
   1 2 3 4 5
   Strongly agree Strongly disagree

7. I could count and time ______________'s exercises easily.
   1 2 3 4 5
   Strongly agree Strongly disagree

8. I think that these procedures would work with other people.

1	2	3	4	5
Strongly agree				Strongly disagree

9. I would implement these procedures with other's who need it.

1	2	3	4	5
Strongly agree				Strongly disagree

10. If _______ had not participated in this study, he/she would not exercise on their own.

1	2	3	4	5
Strongly agree				Strongly disagree

APPENDIX D
CALCULATIONS

I. Equation for determining the total caloric expenditure for the treadmill

A. Determine horizontal 0_2 uptake or cost: $H0_2$ml/kg*min= (0.1 ml/kg*min (constant) * speed (meters/min.) + 3.5ml/kg*min (resting $V0_2$ constant)

B. Change speed to meters per minute: 26.8 meters per minute = 1 mph; so if the treadmills is set at 3 mph, then 3 * 26.8= 80.4 m/min.
EXAMPLE: (80.4 meters per min. * .1 ml/1 kg min. (constant) + 3.5 ml/kg*min.= 11.54 horizontal H_20 uptake

C. Determine vertical 02 uptake or cost: HO_2 ml/kg*min - (1.8 ml/kg*min.) (constant) * speed (meters/min.) * % grade (incline/100=%grade)
NOTE: Grade = percent of incline which ranges from 0 to 15% (in increments of 0.5% grade). This must be converted to a fraction for this equation (e.g. 4.5% = .045)

D. Total 0_2 cost: $V0_2 + HO_2$ = total 0_2 cost in ml/kg*min or “X” ml/kg*min.

E. Convert total 0_2 cost from ml. to liters: “X” ml/kg*min * 1 liter/1000ml = “X” liters/kg*min

F. Convert weight in pounds to kilograms: “X” lbs./2.2 kg. = “X” kg

G. Take the oxygen uptake in liters (step E) and multiply by weight in kilograms (step F): (“X” liters/kg* min.) “X” kg = “X” liters/kg*min.

H. Convert liters per minute into kilocalorie (kcal.) per minute: Take “X” liters/min. (step F) * 5kcal/liter = “X” kcal/min.

I. Determine total number of kcal. burned during the exercise session: Multiply kcal/min (step H) * duration of exercise (t); “X” kcal/min * “Y” min. = “Z” kcal.

II. Equation for determining the total caloric expenditure for walking hall laps (5Oft.)

A. Determine the total number of miles walked: #laps * 50ft/1 lap * 1 mile/5280 ft.; (laps*50/5280 ft.) = Total miles walked

B. Determine the number of miles walked per hour (mph): Total miles walked (step A)/time (min.) = “n” miles/min. “n”

C. Determine total number of calories burned: "n" mph * .012 (constant) = cal/mm/lb = cal/min*lb. ➔

D. Cal/min*lb * weight (lbs) *time (min.) = total calories burned
Note: .012 is the constant for cal./min * lb.

III. Equation for determining the total caloric expenditure for the stationary bicycle
*NOTE: A "MET is the expression of the rate of work (power output) for the human body at rest or a metabolic equivalent" where the MET constant for intensity levels 1, 2, & 3 is 5.5 and 7.0 for intensity levels 5,7, & 9. (Life Fitness, consumer division Ramsey, February 8, 1999)

Main Equation: 0.0175 kcal. (constant)/kg*min*METS = Total caloric expenditure

*Note: Weight must be converted from lbs. to kg. by dividing weight in lbs. by 2.2.

Example: (0.0175k kcal/kg*min*MET) * 5.5 METS * 95.45 kg *45 mm = 413.42 kcal

APPENDIX E
SESSION PROTOCOL

Throughout this experiment, please watch the participants carefully. If you notice any signs of extreme physical distress (e.g., gasping for breath, clutching of the chest, vomiting, disorientation) terminate the session at once, get the group home manager, and call 911.

Rockport Walk-One Mile Fitness Test Pre-and Post-Experiment

The primary investigator will arrange for separate group home field trips to the YMCA. Prior to the field trip departure, participants will be asked the following:

> **"(Subject's name), we are going to the track to take a one-mile walk. Do you want to come along and walk with us?"**

If your participant agrees, take his/her resting pulse at the group home before the test. Researchers shall instruct the participants to sit quietly in a chair for five minutes before taking their pulse. Participants shall be provided with the following instructions:

> **"I want to take your pulse. Please sit quietly in the chair with your feet flat on the floor."**

If the participant speaks during this quiet period or during the actual pulse reading, repeat the following:

> **"Please do not talk."**

Otherwise, do not engage the participant in *any* conversation. At the track, line up on the painted starting line and provide him/her with the following instructions:

> **"(Subject's name), I want you to try to walk around the track four times as quickly as you can. Please begin."**

Start your stopwatch at the verbal prompt:

> **"Please begin."**

Walk along side your assigned participant. He or she is free to stop at any time. You are prohibited from praising them throughout the walk. If the entire one-mile distance is not completed, stop the clock and mark the spot where he/she stopped with the piece of chalk. Record both the distance completed and duration. If it is obvious to you that your participant is not walking as fast as they can or getting distracted (e.g., wandering), provide the following instructions:

> **"Please try to walk faster." Or "Please stay on the track."**

No consequences are in place for either completing or not completing the mile.

Baseline Condition

The research assistant should arrive at the group home on target days (M, W, F) no later than 2 PM, approximately one half-hour before the residents return to the group home. All preparations for conducting the sessions (e.g., gathering writing utensils, data sheets prepared, stop watches checked and set, exercise equipment checked) are to be made in advance *before* participants arrive.

Once the residents arrive, resting pulse rate data should be taken. Researchers shall instruct the participants to sit quietly in a chair for five minutes before taking their pulse. Participants shall be provided with the following instructions:

> **"I want to take your pulse. Please sit quietly in the chair with your feet flat on the floor."**

If the participant speaks during this quiet period or during the actual pulse reading, repeat the following:

> **"Please do not talk."**

Otherwise, do not engage the participant in *any* conversation. Under no circumstances should you address the topic of exercise with the participant. Remain at the group home until the residents sit down for dinner. If the participant does engage in exercise behavior, record the duration, equipment setting, total responses, and take their end exercise pulse when they stop. No consequences are in place for either exercising or not exercising.

Verbal Prompt Condition

On the target days (M,W,F), the research assistant should arrive at the group home no later than 2 PM. approximately one half-hour before the residents return to the group home to prepare for the session. The equipment should be placed on the appropriate setting (e.g., easiest level), gather the necessary tools to conduct the session (e.g., stop watch, writing tools), and the data collection sheets should be readied. Once the residents arrive, resting pulse rate data should be taken. Researchers shall instruct the participants to sit quietly in a chair for five minutes before taking their pulse. Participants shall be provided with the following instructions:

> **"I want to take your pulse. Please sit quietly in the chair with your feet flat on the floor."**

This procedure is the same throughout all conditions of this experiment. After recording resting heart rate, ask the participants if he or she wants to exercise by asking the following question:

> **"Do you want to exercise today?"**

If the participant verbally states that he/she doesn't wish to exercise and does not engage in any subsequent exercise behavior, record their refusal on the data sheet, replace all materials, and leave. No consequences are in place for exercising or refusing to exercise.

If the participant verbally indicates that they want to exercise and they get on the bicycle or treadmill, provide them with the following verbal prompt:

> **"Please begin."**

Start the stopwatch. If the participant does not get on the exercise equipment on their own, provide them with only one verbal prompt to do so. If they still do not get on the exercise equipment, record this as a refusal and terminate the session.

The same procedures are in effect when the participant's target response is walking a pre-determined length of walking area on the group home floor. The only difference is prompting the participant to do the following:

> **"(Subject's name), step up to the tape on the floor. Walk to the end of the hall. When you reach the wall, turn around and walk back to the tape. When you reach the starting tape, turn around and walk back down the hall to the wall. Repeat walking the hall as many times as you wish.**

If the participants fail to begin exercising within one minute of mounting the exercising equipment or lining up on the tape, the session will be terminated.

The participant is free to stop exercising at any time without penalty. You are prohibited from praising or otherwise talking to a participant while he/she is exercising. To avoid making eye contact with the participant, you should stand approximately three to five feet behind the participant and slightly to the left or right of him or her. You should stand so that the equipment LED display is visible to you at all times. When the participant stops exercising, take his/her exercise pulse *immediately* while they remain on the equipment. It is very important that you do this the very second they stop exercising. Record all data on the data collection sheet, collect all session materials, and leave the group home.

Exercise sessions will continue to be conducted in this manner until performance drops off. If performance does not drop off, then you will give the participant a verbal duration prompt based on his/her performance during the previous subphase. You will be told what this duration is before you arrive at the group home to conduct the session. The following is offered as an example of the type of instructions you will be giving:

> **"(Subject's name), do you want to exercise for five minutes?"**

The verbal duration prompts will be systematically increased across subphases until performance drops off. This will precipitate the provision of calories during the next condition.

Differential Reinforcement of Duration

The usual procedures are to be followed for arriving at the group home, preparing for the exercise session, taking the participant's resting heart rate, and conducting the exercise session (e.g., not speaking to the participant while he/she is exercising). The duration criteria will be determined during weekly and bi-weekly lab meetings. The following instructions are given as representative of those expressed during this condition:

> **"(Subject's name), you are required to ride the bicycle (or walk on the treadmill) for _____ minutes in order to earn _____calories. Do you want to exercise today? Please begin."**

Extra commentary or conversation is prohibited. These instructions are to be repeated as necessary in the event that the participant asks questions. As always, the researcher is to refrain from praising the individual while he/she exercises. When the participant stops exercising record all of the necessary data including taking their end exercising heart rate. If the participant does not meet his/her duration criterion, the opportunity to earn calories is forfeited. In the event that this occurs and the participant questions this procedure, repeat the following:

> **"(Subject's name), you were required to ride the bicycle (or walk on the treadmill) for _____ minutes in order to earn _____calories."**

After the participant has successfully completed the session by continuously exercising for the required duration, he or she has earned their calories. The researcher will state the following:

> **"(Subject's name), good job, you've earned your calories."**

The calories will then be immediately added to the participant's calorie sheet by the researcher in the presence of the participant.

Differential Reinforcement of Intensity

The usual procedures are to be followed for arriving at the group home early, preparing for the exercise session, taking the participant's resting heart rate, and conducting the exercise session (e.g., refraining from making eye contact and not speaking to the participant while he/she is exercising). As is the case in determining the duration criteria, the intensity requirement (e.g., equipment setting changes/increases & responses per minutes) will be determined during weekly and bi-weekly lab meetings. The following instructions are given as representative of those expressed during this condition when changing the equipment setting imposes an intensity requirement:

> **"(Subject's name), you are required to ride the bicycle (or walk on the treadmill) for _____ minutes at level _____ in order to earn _____calories. Do you want to exercise today? Please begin."**

When requiring a certain number of responses per minute imposes the intensity criterion, the instructions are as follows:

> **"(Subject's name), you are required to ride the bicycle (or walk on the treadmill) for _____ minutes and complete _____ steps (or pedal rotations) per minute in order to earn _____calories. You can check how you are doing by watching this number** (researcher points to the appropriate area on the display panel). **If this number falls below ______, you will not earn your calories for today. Do you want to exercise today? Please begin."**

If the participants' response rate falls below the pre-determined rate criterion, the participant has forfeited their opportunity to earn calories; however, he/she may continue to exercise. As always, extra commentary or conversation is prohibited. These instructions are to be repeated as necessary in the event that the participant asks questions. The researcher is to refrain from praising the individual while he/she exercises. When the participant stops exercising record all of the necessary data including taking their end exercising heart rate. If the participant does not meet his/her duration criterion *and intensity requirements*, the opportunity to earn calories is forfeited. In the event that this occurs and the participant questions this procedure, repeat the following:

> **"(Subject's name), you are required to ride the bicycle (or walk on the treadmill) for _____ minutes at level _______ (or complete ______steps or pedal rotations per minute) in order to earn _____calories."**

After the participant has successfully completed the session by continuously exercising for the required duration at the increased intensity level (equipment setting changed or response per minute criterion imposed), he or she has earned their calories. The researcher will state the following:

> **"(Subject's name), good job, you've earned your calories."**

The calories will then be added immediately to the participant's calorie sheet in their presence.

Coupon and Choice Manipulation Procedures

1. Instructions for participants given the opportunity to earn calorie coupons contingent upon meeting their duration criteria:

   > **"(Subject's name), you are required to ride the bicycle (or walk on the treadmill) for _____ minutes in order to earn a calorie coupon worth _____calories. The calories will be added to your calorie sheet when you give the coupon to staff. Do you want to exercise today? Please begin."**

2. Instructions for participants given the opportunity to earn calorie coupons contingent upon meeting both intensity and duration criteria:

   > **"(Subject's name), you are required to ride the bicycle (or walk on the treadmill) for _____ minutes and complete _____ steps (or pedal rotations) per minute in order to earn a calorie coupon worth _____calories. The calories will be added to your calorie sheet when you give the coupon to staff. You can check how you are doing by watching this number** (researcher points to the appropriate area on the display panel). **If this number falls below ______, you will not earn a calorie coupon for today. Do you want to exercise today? Please begin."**

3. Instructions for participants given their *choice* of reinforcer contingent upon meeting their duration criterion:

    "(Subject's name), you are required to ride the bicycle (or walk on the treadmill) for _____ minutes in order to earn your choice of a calorie coupon or candy. The coupon is worth _____calories and they will be added to your calorie sheet when you give the coupon to staff or you can have candy right after you finish. Do you want to exercise today? Please begin."

4. Instructions for participants given their choice of reinforcer contingent upon meeting their duration *and* intensity criteria:

    "(Subject's name), you are required to ride the bicycle (or walk on the treadmill) for _____ minutes and complete _____ steps (or pedal rotations) per minute in order to earn your choice of a calorie coupon or candy. The coupon is worth _____calories and they will be added to your calorie sheet when you give the coupon to staff or you can have candy right after you finish. You can check how you are doing by watching this number (researcher points to the appropriate area on the display panel). **If this number falls below ______, you will not earn a calorie coupon for today. Do you want to exercise today? Please begin."**

Be sure to record their reinforcer choice on the data sheet.

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BIOGRAPHICAL SKETCH

Nikki Keefer received her Bachelor of Arts degree from Rollins College in 1993. While earning her degree, she worked at Threshold Inc. in Orlando Florida with Dr. Eb Blakely. She also worked for Deveraux and the Behavioral Services Division of the Department of Children and Family Services, primarily with Drs. Sharon Older and Jose Martinez-Diaz, respectively. These positions required her to conduct functional and descriptive analyses, write behavioral modification protocols, train primary care givers and staff persons, and data analysis.

In 1994, Nikki began her graduate studies with Dr. H.S. Pennypacker when she was accepted into the Department of Psychology in the area of experimental analysis of behavior. She received a Master of Science degree in 1997. Her thesis topic was the differential effects of accuracy versus fluency training on lump detection in silicone breast models.

Over the next several years, Nikki taught general and behavioral psychology classes. She worked as Dr. Carolyn M. Tucker's research assistant on the Research-Based Model Partnership Education Program teaching at-risk African-American students academic, social, and daily-living skills. This program also incorporated a primary caregiver and teacher-training component to deal with behavior problems among other concerns.

Nikki began her dissertation research in 1999 while working with Dr. Kevin Jackson at the ARC of Alachua County. Her dissertation project was designed to determine the effects of a differential reinforcement procedure using calories as reinforcers on the exercise behavior of individuals diagnosed with Prader-Willi syndrome. She also worked one semester with Dr. Timothy Vollmer on a project that trains the caregivers of abused children residing in the state of Florida. Throughout this time, Nikki minored in special education, which gave her an additional opportunity to conduct functional and descriptive analyses of problem behavior, develop data-based treatment protocols, and train caregivers who work and live with autistic and developmentally delayed individuals.

Nikki has conducted several studies on stimulus equivalence training and outcomes, errorless discrimination training, schedule-induced polydipsia and the effects of qualitatively different reinforcers, maladaptive behavior associated with academic performance, and the effects of quality achievement managers (QAMs) on student managers or proctors. Her research interests are in the areas of choice and self-control, stimulus control, stimulus equivalence, reduction of maladaptive behavior, schedule research with clinical populations, and education. In the future, Nikki plans to continue teaching and conducting behavioral research.

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

H. S. Pennypacker, Chair
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

MN Branch

Marc N. Branch
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Timothy D. Hackenberg
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Senior Behavior Analyst, District 14
Department of Children and Families
Developmental Disabilities Program

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Cecil D. Mercer

Cecil D. Mercer
Distinguished Professor of Special Education

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

Carolyn M. Tucker
Professor of Psychology

I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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Associate Professor of Psychology

This dissertation was submitted to the Graduate Faculty of the Department of Psychology in the College of Liberal Arts and Sciences and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Philosophy.

May 2003

Dean, Graduate School